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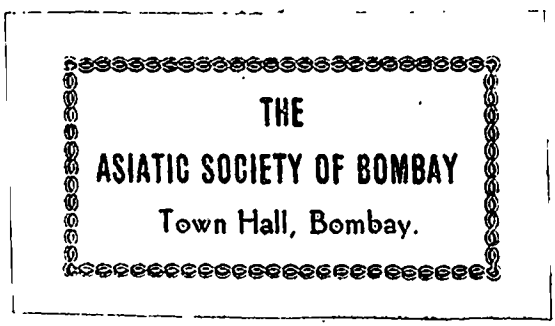

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ACADEMY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

A SYNOPSIS

OF THE

BRITISH DIATOMACEÆ;

WITH REMARKS

ON THEIR

STRUCTURE, FUNCTIONS AND DISTRIBUTION;

AND INSTRUCTIONS FOR

COLLECTING AND PRESERVING SPECIMENS.

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BY

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THE PLATES

BY

TUFFEN WEST,

MEMBER OF THE MICROSCOPICAL SOCIETY OF LONDON.

"Naturam maximè admiraberis, si omnia ejus opera *perlustraris*."—GALEN.

IN TWO VOLUMES.
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PREFATORY NOTE TO VOLUME SECOND.

SINCE the publication of the First Volume of this Work, the researches of Naturalists and Microscopists have considerably extended the number of British species belonging to the genera therein described. I have appended a list of these to the present volume; but I feel satisfied that much yet remains to be done before this field of inquiry can be regarded as sufficiently explored.

Under these circumstances, I have thought it better not to detain the publication of this volume for the engraving of the additional forms already discovered in the British Isles, as this delay would probably render nugatory the attempt to give the work the character of a complete monograph; but to look forward to an opportunity of preparing a Supplement, bringing down the subject to a more advanced stage of observation and inquiry.

For the same reason I abstain from indicating the alterations in the specific arrangements and synonymy of the First Volume, that an acquaintance with new forms and continental specimens would seem to justify or require, as each day supplies fresh materials for a correct judgment, and enables me to modify or confirm with greater certainty the opinions I have already recorded.

The great interest taken in the subject of British Diatomaceæ,

by observers so competent and laborious as Drs. Greville, Arnott, Gregory and others, and the liberality with which their discoveries and opinions are communicated to the public and myself, justify the expectation which I entertain of being able shortly to increase the utility of my work by a valuable accession of new facts and new forms.

I think it right in this connexion to state, that I have no additional evidence enabling me to receive the genus *Dictyocha* as belonging to the Diatomaceæ, and that various features in the structure of the species arranged under the genera *Chætoceros, Goniothecium*, and their allies, constrain me for the present to refuse such forms admission into the present work. An admirable paper by Mr. Brightwell on the British and Foreign Species of some of these genera may be found in the 'Microscopical Journal' for January 1856, and will, it is to be hoped, direct the attention of Naturalists to the determination of the true character and position of these singular organisms.

Queen's College, Cork, March 1856.

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INTRODUCTION.

Section VIII.

Reproduction in the Diatomaceæ.

I have already said (Introduction, vol. i. p. xxviii) that "the circumstances which accompany the reproduction of the Diatomaceæ are too imperfectly understood to permit me to employ them, as I ought otherwise to have done, in the generic arrangement of the species." The three years which have elapsed since I penned this sentence have not materially added to the knowledge then possessed on this interesting portion of our inquiry. The phænomena which attend the formation of the reproductive body are still altogether unknown in many genera, and are only partially understood even where they have been best observed and most carefully recorded.

The little hitherto known upon the subject is primarily due to the researches of Mr. Thwaites, abruptly terminated by his removal to another and wider field of labour, amidst the more luxuriant and attractive vegetation of a tropical climate.

In July 1847, Mr. Thwaites announced, in the pages of the 'Annals of Natural History,' that he had discovered, in the May of that year, a species of the Diatomaceæ, viz. *Eunotia turgida*, Ehr. (*Epithemia turgida*, Kütz., and Synop. B. D. vol. i. fig. 2), in a state of "conjugation."

He was led to adopt this term from the analogy which the process he had detected bore to that occurring in the *Des-*

midieæ, *Zygnemaceæ*, and in other Algæ, and which had already been noticed and described by various writers under this significant title. The facts, he observed, are thus recorded by Mr. Thwaites: and we have copied his figure to give greater distinctness to his description:—"The process of conjugation consists in the union of the endochrome of two approximated fronds, this mixed endochrome developing around itself a proper membrane, and thus becoming converted into the sporangium. In a very early stage of the process, the conjugated frustules have their concave surfaces in nearly close apposition (Plate A. fig. 2. I.); and it may be observed that from each of these surfaces two protuberances arise, which meet two similar ones in the opposite frustule: these protuberances indicate the future channels of communication by which the endochrome of the two frustules becomes united, as well as the spot where is subsequently developed the double sporangium, or rather the two sporangia.

"The mixed endochrome occurs at first as two irregular masses between the connected (conjugating) frustules, but these masses shortly become covered with a smooth cylindrical membrane—the young sporangia (fig. 2. II.), which gradually increase in length, retaining nearly a cylindrical form until they far exceed in dimensions the parent frustules (fig. 2. III.), and at length, when mature, become, like them, transversely striated upon the surface (fig. 2. IV.). Around the whole structure a considerable quantity of mucus has, during this time, been developed, by which the empty frustules are held attached to the sporangia."

Nothing can be more accurate than this description, which would apply to almost every instance of conjugation in the Diatomaceæ.

A few circumstances omitted by Mr. Thwaites, which become of significance when the process is observed in other genera, will be noticed hereafter; in the mean time it is interesting to remark, how exactly conformable to the above account are the phænomena attending the conjugation of other species of the genus *Epithemia*, viz. *Epithemia Sorex* (Plate A. fig. 9), *Epithemia gibba* (Plate A. fig. 13), and *Epithemia ventricosa* (Plate A. fig. 14).

In a postscript to the letter announcing the above discovery, Mr. Thwaites states that he had subsequently detected the process of conjugation and mature sporangia in two species of *Gomphonema* and in *Cocconema lanceolatum*; and in a paper which appeared in the 'Annals' for November 1847, he details and figures these and other cases of conjugation, in the discovery of which I had the pleasure of aiding and co-operating with my acute friend.

In a final communication which appeared in the 'Annals' for March 1848, Mr. Thwaites records two additional examples of the conjugating process in *Cyclotella Kützingiana* and *Schizonema* (*Colletonema*) *subcohærens*, and shows that the enlarged frustules of the *Melosireæ*, which Kützing had conjecturally regarded as reproductive bodies, were in fact the sporangial product of conjugation, the original sporangia submitting to self-division immediately on their formation, and thus forming a chain of frustules larger than those from which they had themselves originated (Plate XLIX. fig. 329).

No further observations on this singular process appear to have been recorded by British naturalists until the appearance of the first volume of the present work, in which I incidentally mentioned the names of various species in which I had detected conjugation, deferring a detailed account of the phænomena attending the process until the present opportunity of recording, in consecutive order, all the examples I had noticed in the British genera.

In the 'Annals of Natural History' for August 1855, an interesting addition was made to the number of genera exhibiting conjugation by Dr. J. W. Griffith, who had observed the process in a *Navicula* (probably *N. firma*) occurring to him in a ditch near Blackwall. The 'Micrographic Dictionary,' in part edited by the same author, in plate vi. fig. 5, March 1855, gives a representation of *Surirella bifrons*, Kütz., in a state of conjugation: and lastly, in the 'Annals of Natural History,' January 1856, we have an account of the phænomena attending the process in *Cocconeis Pediculus*, *Cymbella Pediculus*, Kütz., and *Amphora ovalis*, as noticed by Mr. H. J. Carter of Bombay, all of which appear to have occurred to him in vessels containing larger

Algæ, which he had preserved for examination in a separated and confined condition.

The above comprises all the information on the present subject hitherto accessible to the English reader, if we except a few remarks on the physiology of the process in Professor Braun's 'Rejuvenescence in Nature' (published by the Ray Society, 1853), and which refer rather to the facts recorded by Mr. Thwaites, than to personal observations of the ingenious writer.

I now proceed to record the various examples of the conjugating process which have fallen under my own observation, and to deduce from the whole such conclusions respecting its nature and significance as may appear legitimate and necessary. I shall mention, in the order of their systematic arrangement, the species in which I have noticed conjugation, with the date of the observation, and shall add a reference to the figures in the Plates of the present volume which illustrate the process under its various modifications :—

1. Epithemia turgida, W. Sm., September 1847. Plate A. fig. 2. I.–IV. (from Thwaites).
2. Epithemia Zebra, October 1848.
3. „ Sorex, Kütz., May 1851. Plate A. fig. 9. I. II.
4. „ gibba, Kütz., September 1847. Plate A. fig. 13. I. II.
5. „ ventricosa, Kütz., November 1853. Plate A. fig. 14. I. II.
6. Cocconeis Placentula, Ehr., February 1853. Plate B. fig. 32. I.–IV.
7. Cyclotella Kützingiana, Thw., November 1848. Plate B. fig. 47. I.–IV.
8. Cocconema lanceolatum, Ehr., January 1850 and April 1852. Plate C. fig. 219.
9. Cocconema Cistula, Ehr., August 1850 and April 1852. Plate C. fig. 221. I. II.
10. Cocconema parvum, W. Sm., April 1850.
11. Gomphonema dichotomum, Kütz., August 1850. Plate C. fig. 240.
12. „ tenellum, W. Sm., March 1853.
13. „ olivaceum, Ehr., March 1850, April 1852 and March 1853. Plate D. fig. 244. I.–IV.
14. Gomphonema curvatum, Kütz., March 1849. Plate C. fig. 245. I.–IV.
15. „ marinum, W. Sm., March 1852. Plate D. fig. 246. I.–V.
16. Himantidium pectinale, Kütz., October 1847. Plate D. fig. 280. I.–IV. (from Thwaites).
17. Achnanthes longipes, Ag., July 1849.
18. „ „ β, W. Sm., March 1852. Plate D. fig. 300 β. I.–III.

19. Rhabdonema arcuatum, Kütz., November 1849 and March 1852. Plate E. fig. 305. I.–III.
20. Melosira nummuloides, Kütz., October 1852. Plate XLIX. fig. 329. *f''*.
21. „ Borrerii, Grev., March 1852. Plate L. fig. 330.
22. „ subflexilis, Kütz., March 1852. Plate LI. fig. 331. *f. sp.*
23. „ varians, Ag., October 1851. Plate LI. fig. 332. *f. sp.*
24. Orthosira orichalcea, W. Sm., October 1855. Plate E. fig. 337. I.–IV. (from Thwaites).
25. Encyonema prostratum, Ralfs, April 1852. Plate E. fig. 345. I. & II.
26. Colletonema subcohærens, Thw., October 1847. Plate E. fig. 353.
27. Schizonema Grevillii, Ag., July 1849. Plate E. fig. 364.

If we add to the above list *Navicula firma*, Kütz., and *Surirella bifrons*, Kütz., as recorded by Dr. Griffith, together with *Cocconeis Pediculus*, Kütz., *Cymbella Pediculus*, Kütz., and *Amphora ovalis*, Kütz., detected by Mr. Carter, we shall have in all thirty-two species belonging to seventeen genera, which have been observed in a state of conjugation. These numbers are small in proportion to the whole of our ascertained British forms, and leave much to be accomplished by future observers. One reason for the paucity of observations on this process in the Diatomaceæ is no doubt to be found in the changes which usually take place in the condition of these organisms at this period of their existence. During conjugation the progress of self-division is arrested, the *general* mucus-envelope or stratum, produced during self-division, is dissolved, and the conjugating pairs of frustules become detached from the original mass; they are thus more readily borne away and dispersed by the surrounding currents, or the movements of worms and insects, and their detection becomes in consequence more casual and difficult. By far the greater number of the species I have mentioned belong to those genera whose frustules are adherent or attached by stipes to foreign bodies, or which form continuous filaments or aggregated frondose expansions. Not more than four, viz. *Cyclotella Kützingiana*, *Navicula firma*, *Amphora ovalis*, and *Cymbella Pediculus*, are to be regarded as free forms: the reason I have just given will account for this circumstance, and the larger proportion of adherent or frondose species detected in conjugation may doubtless be ascribed to the firmer position

conferred upon such forms by the presence of these accessory methods of attachment and adhesion; while the filamentous species, being usually aggregated in considerable masses, or entangled amidst the branches of the larger Algæ, are also less liable to dispersion.

From an examination of the figures referred to in the above list, it will be seen that while the general character of the process, which consists in the intermingling of the endochrome or cell-contents of the parent frustules, is the same throughout, there are peculiarities attending the process in the different genera which prevent us from giving a detailed description of the phænomena that will apply to every case. The most notable of these peculiarities are the variations in the number of the conjugating frustules and the sporangia which result from the process. These variations may be reduced to four classes.

I. We have two parent frustules and two sporangia as the result of their conjugation. This mode is seen in *Epithemia*, *Cocconema*, *Gomphonema*, *Encyonema*, and *Colletonema*.

II. From the conjugation of two parent frustules we have a single sporangium. This occurs in *Himantidium*.

III. The valves of a single frustule separate, the contents set free rapidly increase in bulk, and finally become condensed into a single sporangium. This may be seen in *Cocconeis* *, *Cyclotella*, *Melosira*, *Orthosira*, and *Schizonema*.

* I have not attempted to reduce the examples of conjugation given by Dr. Griffith and Mr. Carter to any of the above classes. In the details and figures of these writers there are circumstances which I cannot explain in accordance with the known phænomena attending conjugation in other cases, and the significance of which I cannot comprehend without a personal examination of specimens.

Judging from the figures given by Dr. Griffith of the conjugation of *Navicula*, I should refer that genus to the third mode I have mentioned; but the text of Dr. Griffith's paper, speaking of "parent frustules," would point to my second mode as the process he had observed. The "rugose siliceous sheath" enveloping the sporangium, as described by Dr. Griffith, I have never observed; probably it may have been an *appearance* resulting from the condensation and corrugation of the mucus developed around the reproductive body. If the figure given in the 'Micrographic Dictionary' of the conjugation of *Surirella* be correct, that genus will also fall under my second class.

In Mr. Carter's paper, the formation of two sporangia in *Cymbella* and

In *Melosira nummuloides*, *M. Borrerii*, and *M. subflexilis*, the second valve of the conjugating frustule is rarely found united to the mucus surrounding the sporangium, the conjugation taking place only in the last frustule of the filament; but in *Melosira varians* and *Orthosira orichalcea*, conjugation taking place throughout the entire filament, both valves are usually found adherent to the sporangium or its surrounding mucus.

IV. From a single frustule, as in the last method, two sporangia are produced in the process of conjugation: this takes place in *Achnanthes* and *Rhabdonema*.

However varied these methods may appear on a superficial view of the conjugating process, they will not, on a further consideration of the nature of these organisms, be found to involve any physiological diversities.

We have already remarked, that, "during the healthy life of the Diatom, self-division is being continually repeated (Introd. vol. i. p. xxv); while the frustule is performing the simple functions of its life and growth, its contents are therefore being continually submitted to the separative process which precedes the self-dividing act. The functions of life and growth are not suspended during the act of conjugation, and in consequence self-division may take place at any stage of the process which accompanies the formation of the reproductive body; or the latter process may intrude upon, or arrest any step in the progress of self-division.

In the first mode of conjugation, as occurring in *Epithemia*, &c., self-division may be regarded as in the earliest stage of its

Amphora is represented as the result of the conjugation of *two* frustules; these genera must therefore be referred to my first class. The conjugation of *Cocconeis* is *described* as similar to the others, but two of the figures given, viz. figs. 5 & 6, harmonize the process with that noticed by myself in the same genus.

The circumstance dwelt upon by Mr. Carter as having an important bearing upon the *rationale* of the process, viz. that one of the conjugating frustules is invariably smaller than the other, is altogether at variance with my experience, and is totally irreconcilable with the process as it occurs in the genera mentioned under my third and fourth classes. I am therefore disposed to believe that the difference in size noticed by Mr. Carter was a mere accidental diversity, and of no essential signification.

progress, which merely involves the separation of the endochrome of the parent frustules into two portions, but does not include such a differentiation of these portions as renders them capable of the conjugative act: the endochrome capable of conjugating with these segregated portions must be sought for in other frustules; hence the process in these genera involves the presence of two parent frustules, and results in the production of two sporangia.

In the second mode, met with in *Himantidium*, the progress of separation is arrested at a still earlier stage; no differentiation has taken place, and conjugation intervening, necessitates the union of the entire contents of two parent frustules to form a single sporangium.

In the third mode, the progress of the separation of the endochrome in the parent frustule must be considered as so far advanced that complete differentiation has taken place. In every respect but the formation of new valves, self-division has been completed; the incomplete frustules are therefore prepared for conjugation, which, intervening at this stage, leads the observer to believe that but one frustule has been concerned in the production of the single sporangium. This we see in *Melosira* and the other genera mentioned under this class.

And lastly, self-division occurring during the progress of conjugation, the endochrome becomes segregated in the very act of intermingling, and a single frustule, whose contents have been already differentiated, gives rise to two sporangia, as in *Achnanthes* and *Rhabdonema*.

Nor is the self-dividing disposition in all cases permanently arrested by the complete formation of the sporangium. Having assumed the form of the parent frustules, with a great increase in size (the enlargement in dimensions being in some cases due to the accumulation of the contents of the two conjugating frustules, and in others, to a rapid assimilation of nutritive material from the surrounding medium), the sporangial frustule immediately submits to self-division, and by the repetition of this act developes a series of frustules equal in size to the original product of the conjugating process. This is notably the case in the filamentous species, as may be easily seen in *Melosira*,

Plate XLIX. 329*f*', and Plate LI. 331.*f. sp.*; *Orthosira*, Plate E. 337. III. IV. & V.; and in *Himantidium*, Plate D. 280. IV. How far this self-division may be carried in the sporangial frustules is at present unknown; it is probably of short duration, as we rarely meet with any considerable number of frustules characterized by the enlarged size of the sporangial form. In most cases an arrest of growth, and consequently of self-division, seems immediately to follow the complete formation of the sporangia, and the reproductive body assumes the quiescent character which belongs to the seed of the higher plant, its vital function remaining dormant until circumstances favour its further development, and the production of the young frustules, of which it is the destined parent.

The mode of this development is imperfectly understood, the dispersion of the sporangial frustules by the dissolution of the investing mucus usually removing the reproductive bodies from the sphere of ready observation: cases, however, have fallen under my notice, which seem to indicate that the further process of reproduction consists in the resolution of the contents of the sporangium into a "brood" of Diatoms having the same form and specific characters as the original frustules which originated the sporangia. In the gathering of *Cocconema Cistula* made in April 1852, which contained numerous instances of the conjugating process, I observed the frequent occurrence of cysts enclosing minute bodies, variable in their number and size, and many of which had the outline and markings of the surrounding forms, and were obviously young frustules of the *Cocconema*: these cysts and their contents are figured in Plate C. 221. III. IV. & V. It would appear from these figures, that the production of the young frustules is preceded by the separation and throwing-off of the siliceous valves of the sporangium, and the constriction or enlargement of its primordial utricle, according to the number of young frustules originating in its protoplasmic contents. In this gathering, forms of every size intermediate between the minutest frustule in the cyst and the ordinary frustules engaged in the conjugating process (Plate C. 221. I.) were easily to be detected, and the conclusion was inevitable, that the cysts and their contents were

sporangia of the species with which they were associated, and indicated the several stages of the reproductive process.

In another gathering containing *Synedra radians*, W. Sm., collected by Christopher Johnson, Esq., at Hamson, Lancashire, October 1851, the cysts containing "broods" of frustules evidently belonging to the accompanying species were of frequent occurrence. The progress of development was not so fully traced as in the case of *Cocconema Cistula*, as there were not any examples in the Hamson gathering of the conjugated state of the *Synedra*, but the appearance of the cysts and their contents was equally characteristic with the former of the reproductive process; and on a subsequent occasion, and at a distant locality, I had the pleasure of detecting similar phænomena in connexion with the same species, leaving no doubt on my mind that the cystoid condition is one stage in the normal method of its reproduction. Figures representing this state of *Synedra radians*, as collected by myself in the neighbourhood of Lewes, in the county of Sussex, November 1853, are given in Plate B. 89.

On the whole, the facts at present within our knowledge seem fully to warrant the conclusions that the conjugated state of the Diatomaceæ is the first step in the reproductive process of these organisms, and that the sporangial products of this condition become the parents of numerous young frustules destined to renew the cycle of phænomena which accompanies the life and growth of the species from which the sporangia have themselves originated.

That frequent, and apparently accidental or abnormal modifications in the reproductive process should characterize its progress in the Diatomaceæ, will not surprise those who are intimately acquainted with the lower tribes of plants. The character of the structure and organization which distinguishes such organisms involves but little specialization of function, and admits an amount of disturbance and seeming irregularity that would be altogether inconsistent with the more complex structure and specialized functions of the higher plant. There is nothing, however, in the history of the reproductive process among the Diatomaceæ inconsistent with the ascertained laws which regulate the growth of unicellular plants, or which

cannot be explained in accordance with the ascertained phænomena which characterize embryonic development in its earliest stages in all the simpler forms of Thallogens and Protophyta.

Another mode of reproduction, or rather a modification of the process I have detailed, has been briefly described and imperfectly figured by Rabenhorst (Süsswasser Diatomaceen, p. 3. taf. x. Suppl. F. 18), who represents the contents of the sporangium of a *Melosira* as being converted into active "gonidia," and escaping from the cell in the same manner as the zoospores of *Sphæroplea* from the cells of its filament It is possible that such a process may take place, this method of development being far from unfrequent in the lower Algæ; its occurrence in the Diatomaceæ cannot, however, be received as established without further observation, and a more careful record of the phænomena attending its progress.

Section IX.

On the Nature of the Diatomaceæ.

It will be seen from the observations already made, that the opinion of the writer of the present work accords with that of the generality of authors who have treated of the Diatomaceæ, and leads him to place these forms in the ranks of the vegetable kingdom. Some of the earlier writers upon the subject, misled by superficial and obvious characteristics, placed these organisms among animals, and, influenced by this idea of their nature, persuaded themselves of the presence in the Diatomaceæ of prehensory, digestive, and locomotive organs. The careful and unbiassed researches of later observers, aided by microscopical appliances of a more trustworthy kind, have satisfactorily demonstrated that the simplicity of function which belongs to a Diatom is wholly irreconcileable with the existence of such organs as a mouth, stomach, or feet; and the more accurate the examination, and the more complete the instrument of observation, the more certain is the persuasion that the Diatomaceous frustule is a single cell, homologous with the same organisms in the Desmidieæ and other Protophyta, and with the

individual cells which enter into the structure of the higher plants.

The controversy respecting the nature of the Diatomaceæ may therefore be considered as determined in favour of their vegetable character.

If any doubt at present exist on the subject, it appears to arise from the difficulty of reconciling the movements which accompany the vital functions of the Diatomaceæ with the prevalent conditions of plant-life, and of harmonizing the structure of their siliceous epiderms with the ordinary forms under which cellulose occurs throughout the vegetable kingdom.

These points require elucidation. The isochronal movements of the Diatomaceous frustule, already described (Introduction, Vol. i. Sect. II.), have always presented a difficulty to their admission into the class of plants, with those who regard motion as a special attribute of animal life: and the peculiarity of these motions, even with observers who know that movement is of frequent occurrence in the earlier conditions of vegetable development, has, perhaps unconsciously, been the occasion of doubt and hesitation in forming positive conclusions respecting the nature of such organisms. It ought, however, to be remembered, that if these motions are singular in the vegetable kingdom, they are unparalleled in the animal world, are wholly devoid of those evidences of volition which are apparent throughout the latter department of nature, and irreconcileable with the idea of a living organism endowed, as are the lowest forms of the animal being, with the power of voluntary movement. In the vegetable kingdom alone we meet with actions presenting analogous phænomena; the filaments of the *Oscillatorieæ*, while in a growing state, exhibiting motions, which, taking into account the differences of structural arrangement, may be regarded as similar to those of the Diatomaceæ. The excessive rapidity of growth which characterizes the *Oscillatorieæ* appears a satisfactory explanation of the vibratory movements of their filaments; the same activity in their vegetative functions will go far to explain the oscillatory motions of the Diatom, and to harmonize the character of its frustule with the attributes of the vegetable rather than the animal being.

The complex structure of the siliceous valves which enclose the frustules of the Diatomaceæ has also been regarded as incompatible with their location in the vegetable kingdom. Much of this complexity is apparent rather than real, and is due to the refractive nature of the material which enters into combination with the outer membrane of the cell-wall. In every case this membrane is more or less penetrated or imbued with silex; and the presence of this substance appears to have modified the intimate structure of the membrane, and induced great variety in the mode and character of its formation in different genera accompanied by great regularity in the individual species.

These variations exhibit themselves in the different modifications of structure which constitute the markings of the valves, appearing under the form of ribs and nodules, costæ, striæ, or cellules of an elliptical, circular, or hexagonal outline. A wide comparison of specimens seems to me to prove that these various markings originate in the tendency impressed upon all organized structure to develope itself upon the type of the cell, and that the presence of the siliceous constituent in the cell-membrane of the Diatom gives a fixedness to this tendency, which, in ordinary cases, is either not discernible in the structure of the membrane, or whose effect is obliterated by the coalescence of the softer material which constitutes its substance. However this may be, it appears to me certain that the structure of the siliceous valve in the Diatomaceæ is invariably cellulate, the cellules being more or less modified according to the peculiar requirements of each species, and that no other explanation of their characteristic markings seems consistent with the facts which are established by a careful examination and comprehensive knowledge of Diatomaceous structure. That this explanation does not involve considerations at variance with the conditions of unicellular vegetable life will be obvious to any one familiar with the structure of the siliceous epiderm in the *Equisetaceæ* and *Graminaceæ*, and the distinctly cellulate structure of many pollen-grains; while this very presence of silex as a constituent of the cell-wall in the Diatomaceæ appears to be wholly unaccountable except on the supposition of the vegetable nature of these organisms. In no instance do we find a parallel condition in

the animal kingdom, for the secretion of siliceous spicula, as an *internal* skeleton, in some of the Spongidcæ, cannot be regarded as an analogous phænomenon; whereas the vegetable kingdom furnishes us with cases, not merely of the secretion of silex as a vegetable product in the Bamboo, but with frequent instances of its intimate union with cellulose in the membrane which forms the epiderm of the cell, as in the Natural Orders already mentioned, in the Palmaceæ and others.

The rapid evolution of oxygen from the frustules of the Diatomaceæ while in the active discharge of their nutritive function, under the influence of the sun's light and heat, is another circumstance which confirms the view we have taken of their vegetable nature: this may be noticed in any mass of Diatomaceæ during the warmer months of the year, or in gatherings freely exposed to the sun, in the elevated temperature of a confined apartment during the winter or spring. Under these conditions the water in the vessel becomes covered with minute bubbles of oxygen, and portions of the Diatomaceous stratum are floated up by the buoyancy of the globules of this gas adhering to their frustules. Such phænomena can only be accounted for by supposing that the Diatomaceæ are plants, and that they exhale, like all plants in a state of active vegetation, oxygen from their tissues; but this process is irreconcileable with the hypothesis of their animal nature.

Another view of the nature of the Diatomaceæ has been advocated by some writers, who, admitting that the arguments for the animality of these organisms are devoid of weight, maintain that the evidence of their vegetable nature is equally inconclusive, and contend that they occupy a neutral position between the two kingdoms, and cannot in the present state of our knowledge be assigned to either. It does not appear to me that any benefit would accrue to physiology or science by thus constituting a new domain of being, occupied by organisms of indefinable and mysterious attributes, and for whose description, if description in their case were possible, it would be necessary to invent a new and probably unintelligible nomenclature. This would be merely to disguise our ignorance under the veil of a metaphysical sophistry. It may be admitted, that in the case of

entities so simple and minute, it is difficult to detect any very manifest specialties of function, or to assign to them the attributes that are obviously characteristic of higher organisms; but if we can show that their organization ministers to functions that are purely of a vegetative kind, and that none of the circumstances which attend their growth, development, and reproduction, are inconsistent with the known phænomena of plant-life, we are warranted, and indeed constrained, to associate them in a systematic arrangement with that department of organized being to which they are thus functionally and structurally allied, or from which at all events they are not in these respects excluded by any well-ascertained or notable diversities.

We conclude then that the Diatomaceæ are plants belonging to the Sub-Class Algæ; or, following the more recent systematists, to the Class Protophyta, all of whose forms, unless when united into filaments, or aggregated into masses by the mechanical aid of the mucus they so frequently secrete, are microscopic and unicellular,—homologues of the component parts of the tissue which forms the entirety of the Thallogen, and enters largely into the composition of the higher and more organized forms of vegetable life. The Diatomaceæ, with specialties of their own, have also intimate alliances with the other orders of the Protophyta, resembling the *Zygnemaceæ* and *Desmidiaceæ* in the reproductive process,—the *Nostocaceæ* in the tendency shown by several genera to surround their frustules with frondose masses of mucus, within which linear series of cells are subsequently developed,—the *Oscillatoriaceæ* in their movements,—the *Palmellaceæ* and all the orders I have named, in the self-dividing act by which the individuals of the species are multiplied, or the aggregate of specific life maintained and increased.

Section X.

On the Determination of Species in the Diatomaceæ.

In an order prolific of forms, so minute in size, and simple in organization, it is by no means an easy matter to fix upon any certain elements of specific arrangement.

The determination of genera being mainly an artificial mode of aiding research, or conveniently grouping together forms possessing in common important and obvious characteristics of structure or of function, must, to a great extent, be influenced by the theoretic views, and be left to the experience or judgement of the individual inquirer; but it is far otherwise with the determination of species. We here seek to discover the distinctions which have been impressed by nature upon every individual derived by reproduction or by self-division from the original product of the creative act. Such distinctions may, to our powers of apprehension or discovery, be of the slightest kind, and may, in the marvellous minuteness and multiplicity of these organisms, blend into one another by gradations too fine to be detected by any appliances that we can employ. In an attempt to accomplish this object, it is a point of the first importance to select peculiarities of structure or organization which in their main features are common to every species in each genus we may adopt, and yet exhibit variations in each species of such genus. If several such peculiarities can be found, our task would be an easy one; but the simplicity of organization in the Diatomaceæ forbids this expectation, and usually reduces us within narrower limits. I shall lay before the inquirer the results of my own experience on this subject, without claiming for the conclusions to which I have arrived any absolute authority, feeling assured that a far wider knowledge of these forms than that to which I can at present pretend, would be necessary to give to such conclusions the weight of established truth.

We have seen that the ordinary Diatomaceous frustule owes its reproduction to the protoplasmic contents of the sporangial frustule formed during the process of conjugation.

The embryonic frustules which are generated within the sporangial cyst, having, by their increase in size, burst the membrane which contains them, escape from the cyst, and in a definite, but unascertained period, reach the mature form and size of the ordinary fructule.

The further growth and modification in form of the individual cells seem now to be arrested by the consolidation of the sili-

ceous valves; and the multiplication of these forms, of the size thus reached, goes on with inconceivable rapidity by means of self-division.

The size of the mature frustule before self-division commences, is, however, dependent upon the idiosyncrasy of the embryo, or upon the circumstances in which its growth takes place; consequently a very great diversity in their relative magnitudes may be noticed in any large aggregation of individuals, or in the same species gathered in different localities. Moreover, while a typical outline of its frustule is the general characteristic of a species, this outline may be modified by the accidental circumstances which surround the embryo during its growth, and the development of its siliceous epiderm.

The process of self-division now intervening, and necessarily stereotyping the shape with which it commences, multitudes of frustules slightly deviating from the normal form are subsequently produced, so that the observer, judging from a single gathering, may be led to fix upon a variety as representing the typical form and size of the species.

It follows from these circumstances that neither size nor outline is sufficient to enable the observer under ordinary circumstances to determine the species of a Diatomaceous frustule: well-marked diversities of shape, depending upon structural peculiarities, may be an auxiliary guide in the adoption of generic distinctions; but the slighter and accidental variations, which occur during the development of the individual frustules, forbid us to employ such characters in the determination of specific forms. If the observer have the means of comparing specimens in sufficient numbers and from various localities, he may fix with tolerable accuracy upon the magnitude and form which may be regarded as the average and type of the species; but without these opportunities, a reliance upon such characters will lead to an undue multiplication of species, and to a confusion and indefiniteness in their arrangement that will embarrass and mislead the future inquirer.

One specialty in the Diatomaceous frustule, presenting important modifications that may be introduced with propriety into our generic descriptions, and at the same time offering

slighter variations in each species, sufficiently constant to form a safe guide to their determination, is the influence which the presence of the siliceous element, in the composition of the valve, has, in modifying the cellulate character of its structure, and producing diversities in the number, extent, and form of its markings.

These variations of structure arise from the modes in which the silica combines with the cellulose of the epiderm; and this combination seems to obey certain and invariable laws, which are subject to but slight derangement from the external circumstances in which the growth of the embryo takes place. The more important variations arising from this cause exhibit themselves in the presence or absence of aggregations of the siliceous material in the form of a median rib or line with its central and terminal nodules, under several very characteristic modifications —in the presence or absence of other transverse and strengthening bands of silex, and in the obvious varieties of form or combination to which the cellules submit in the progress of their formation, exhibiting themselves as hexagonal, circular, or irregular in outline, as distinct from each other, or as more or less confluent. These characters, in some cases useful as specific distinctions, are more frequently available in the arrangement of the genera and their subdivisions. Less conspicuous features in the cellulate structure of the valve will be found necessary in the determination of specific forms.

Whether the striæ, resulting from the cellulate character of the structure, are mutually parallel or radiate in their arrangement, reach the median line, or are absent from a greater or lesser portion of the valvular surface—whether the cellules themselves are arranged in squares or disposed in quincunx, and the striæ in their transverse direction are consequently parallel or oblique in reference to the margin or the median line —the relative distances of the striæ and their greater or less distinctness,—all these are features which may safely be regarded as of specific importance, and though subject to slight modifications, arising from the accidents of locality and age, are sufficiently constant to enable us to associate together frustules which owe their birth to the same sporangium, and which, on a renewal

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of the conjugating process, will produce frustules with the same specific characters as themselves. In describing a species, we should therefore carefully note the character of the striation, and state as nearly as possible the average distance of the striæ. The dry valve will frequently aid in such determination, the presence and extent of the striation being usually indicated by the colour of the surface, and the differences in colour not unfrequently answering to the relative distances or distinctness of the striæ.

Another feature, which appears in its modifications to confer a specific character upon the Diatomaceous organism, is the arrangement of the endochrome or cell-contents in the living frustule. These modifications are familiar to those who are accustomed to the examination of freshly gathered specimens of the Diatomaceæ, and are found to be constant and characteristic of each specific form. In one case the endochrome is closely applied to the inner surface of the valve; in another, aggregated in the centre of the frustule; sometimes sparingly diffused throughout the interior, or again exhibiting a radiate or stellate arrangement; at all times having one or several oily(?) globules which occupy in different species different positions, but are constant in number and situation in the same species.

Should both these methods of determining the species fail the inquirer, there remains a third which will often aid him in the desired discrimination, viz. the locality in which the specimen has been discovered. I feel persuaded that a marine species will not flourish under fluviatile influences, nor a freshwater form long survive when transferred to a marine habitat. Still further, I believe that certain species are far more special in their tastes, some selecting mountain-torrents, others clear and still waters; some preferring the deltas of rivers, and others fixing their habitation in boggy pools or alpine lakes; some being exclusively littoral, and others found only in the deeper parts of the sea.

Where structural differences are not obvious, when striation is indistinct or too minute for detection, and the arrangement of the cell-contents is modified by the death of the frustule, a knowledge of the habitat of the specimen, when in a living state,

will thus assist in the resolution of our doubts, and enable us to assign to a form a systematic position and a specific name.

These remarks, if they do not enable the inquirer to arrive at certainty in the determination of specific characters, will at all events, it is to be hoped, guard him from the rash conclusions and hasty generalizations of the amateur microscopist, who is disposed to rely upon the obvious characteristics of size and form, and to regard such features as important distinctions.

Among organisms of such simplicity, these latter characters are far from sufficient to establish specific distinctions, and it requires a careful examination of specimens collected in various localities, and in every condition of growth, to enable the observer to fix upon the size that may be taken as the average, or the outline which ought to be regarded as the type. Striation is the best guide; but it sometimes happens that this feature is so obscure, or so alike in allied species of the simpler forms, as *Cocconema*, *Cymbella*, or *Navicula*, that our determinations must be influenced by other considerations, and the arrangement of the endochrome, or the habitat of the living frustule, or even less important considerations, must be taken into account. A neglect of these precautions will lead to the multiplication of synonyms, to vagueness of description, and to a cumbrous and unscientific nomenclature.

Section XI.

On the Distribution and Uses of the Diatomaceæ.

The geographical range of the Diatomaceæ is so much more general and uniform than that of the higher orders of plants, that it would seem to be an established fact that many of the commoner species are universally distributed throughout the waters of the globe. There is, however, some difficulty in coming at very certain conclusions on this point in reference to any large number of species, both from the little attention that has hitherto been paid to the subject by the generality of naturalists, and from the imperfect representations given of the forms observed.

Professor Ehrenberg has indeed discussed the subject on a

wide and comprehensive plan, and given to the world, in his late great work, the 'Microgeologie,' the results of researches to which he has devoted an amazing amount of laborious patience. Many of the gatherings described by this writer belong to formations of a date sufficiently recent to illustrate the distribution of living forms, but unhappily the want of specific descriptions, and of minute accuracy in the figures, are serious drawbacks to the value of the 'Microgeologie' in the hands of other observers not in possession of the specimens themselves, and leave much to be desired by those who would seek to adopt its statements as the basis of their generalizations. Without the confirmatory evidence of personal observation, I therefore hesitate to bring my own experience into parallelism with the statements of this great authority, and content myself with the humbler task of mentioning a few casual facts that have fallen under my own notice; many of them will be found recorded in the body of this work; but a notice here of some of the more curious or important may interest the general reader.

Of freshwater species frequent in the British Islands, the following seem almost cosmopolitan, viz. *Synedra radians, Pinnularia viridis, Pinnularia borealis,* and *Cocconema lanceolatum.* Gatherings from many localities in Europe, from Smyrna, and Ceylon, from the Sandwich Islands, New Zealand, and New York, from the loftiest accessible points of the Himalaya in Asia, and the Andes in America, have supplied specimens of these forms.

Navicula serians abounds in all our mountain bogs, and is equally common in the marshes of Lapland and America.

Epithemia gibba is an inhabitant of the Geysers of Iceland and the lakes of Switzerland.

The South Sea Islands supply *Stauroneis acuta,* and Ceylon *Synedra Ulna*; while *Stauroneis Phœnicenteron* is equally abundant in Britain, Sicily, and Nova Scotia.

These notes of localities will give some idea of the wide distribution of our fluviatile Diatomaceæ; more numerous gatherings would no doubt greatly extend the list, and the following circumstance will show how generally our commoner British forms are diffused throughout European localities that

have been carefully examined. During a tour in Languedoc and the Auvergne, in the spring of 1854, I made upwards of forty gatherings from the rivers, streams and lakes of the district I traversed; in these I detected one hundred and thirty species, described in the present work, and but one form not yet determined as indigenous to Britain. If this be the case with a district, much of whose Phanerogamous flora is so different from our own, it bears out the view I have taken, that these organisms enjoy a range of distribution far more general than the higher orders of plant-life.

Nor is the distribution of marine species less notable for its extent and uniformity. *Coscinodiscus eccentricus* and *Coscinodiscus radiatus* range from the shores of Britain to those of Southern Africa. *Grammatophora marina* and *Grammatophora macilenta* are found in almost every marine gathering from the Arctic Ocean to the Mauritius. *Stauroneis pulchella*, *Cocconeis Scutellum*, and *Biddulphia pulchella* are equally abundant on the European, the American, and the African coasts; while *Rhabdonema Adriaticum* belies its name by its occurrence in the Indian, Atlantic, and Pacific Oceans. During the researches already mentioned in the South of France, I made several prolific gatherings on the shores of the Gulf of Lyons; but of thirty-three forms occurring in these, *Hyalosira delicatula*, Kütz., was the only one not familiar to me as a British species.

Of the purposes served by the wide diffusion of these organisms it is impossible to speak with certainty. Their minute size forbids us to attribute much effect to their individual influences; but when we regard them as aggregated in numbers that defy enumeration, we are compelled to believe that they occupy an important place and subserve necessary ends. Their nutritive process, which involves the absorption of carbonic acid and the extrication of oxygen, must tend to preserve the purity of the water in which they are found, and to prepare it for the respiration of aquatic animals. Their presence in the stomachs of Infusoria, Annelida, Mollusca, and Crustacea, shows that they constitute to some extent the food of these animals; and the vast numbers of their siliceous valves which occur in Guano, prove that they are swallowed in large quantities by birds, and minister

to their sustenance. Their *direct* uses to man are probably few and unappreciable, except in the mechanical arts, where, as I have before stated, the powdery debris of their frustules, from its siliceous character, is profitably employed as a polishing material: indirectly they doubtless contribute to the fertility of the soil, and promote the growth of many of the cereal grains which furnish the human family with the farinaceous elements of food. This is the more probable, if it be true, as Ehrenberg and other writers have asserted, that moist ground everywhere exhibits the presence of these organisms. A singular instance in illustration of this has been mentioned to me by Dr. Gregory, who states, that upon examining the particles of earth adhering to the roots of plants collected in various and widely separated localities, he almost invariably detected Diatomaceæ.

The result of the presence of these forms in vegetable mould must be the extrication of silica from the fluids in the soil, and its deposition after the death of the Diatomaceæ, in another condition, that may, in some unexplained manner, minister to the healthy growth of larger plants.

But even should we fail in our attempt to explain the precise objects of the Diatomaceæ in the economy of being, we may rest assured that organisms of such infinite variety have not been formed in vain; and that the time we may occupy in the study of their functions, or in the admiration of their marvellous symmetry, will not have been idly spent, if it enhance our conceptions of creative skill, and strengthen our persuasion of the omnipotent power and diffusive energy of the divine Artificer of Nature.

ADDENDA ET CORRIGENDA.

THE following Diatomaceous earths referred to in the present volume, are to be added to the list given in Vol. i. p. 5 :—

MULL DEPOSIT. Described by Dr. Gregory in the Transactions of the Microscopical Society for 1853 ; and in the Quarterly Journal of Microscopical Science, vol. ii. 1854.

NEWBIE DEPOSIT. Described by Professor Harkness in the Edinburgh New Philosophical Journal, July 1855.

Page 12, add to the description of *Himantidium pectinale*: var. β. Frustules with internal cells. Blarney, Co. Cork, March 1856.

12, line 8 from bottom, for *undulatum* read *undulata*.

28, line 2, *for* never *read* rarely: authentic specimens of *Achnanthes Capensis* supplied by Dr. Arnott, and which are identical with my *A. brevipes*, have stipes occasionally longer than the frustules.

43, insert a reference to Plate XLII. 315, for *Grammatophora serpentina*.

66, to the habitat of *Mastogloia Grevillii* add, Gill Banks near Ulverstone, March 1856, *Miss E. Hodgson*.

In Plate LXI., last line, *for* maculatum *read* macilenta.

SYNOPSIS

OF

THE BRITISH DIATOMACEÆ.

PRELIMINARY NOTICES.

VOL. II.

In addition to those previously mentioned, the following works are referred to in the present volume.

Bail. Mic. Org. Notes on Microscopical Organisms. By Professor J. W. Bailey (in Smithsonian Contributions to Knowledge), Feb. 1854.

Bréb. Diat. Cherb. Note sur quelques Diatomées Marines du Littoral de Cherbourg, par M. Alphonse De Brébisson, 1854.

Ehr. Microg. Microgeologie: von Christian Gottfried Ehrenberg. Leipzig, 1854.

Greg. Mic. Journ. Papers in the Quarterly Journal of Microscopical Science. By William Gregory, M.D., F.R.S.E., Professor of Chemistry in the University of Edinburgh. v. d.

Greg. Mic. Trans. Papers in the Transactions of the Microscopical Society of London. By Dr. Gregory. v. d.

Grev. Ann. A paper in Annals of Natural History: by R. K. Greville, LL.D., April 1855.

Meneg. Diat. On the Animal Nature of Diatomaceæ. By Professor G. Meneghini. Translated by Christopher Johnson, Esq. (in Ray Society's Publications), 1853.

Mic. Dict. The Micrographical Dictionary. By J. W. Griffith, M.D., F.L.S. &c., and Arthur Henfrey, F.R.S., F.L.S. &c., parts i. to xv. 1854–55.

Oked. Diat. Dep. On deep Diatomaceous Deposits. By Fitzmaurice Okeden, C.E. Quart. Journ. of Micr. Science, 1855.

Raben. Süssw. Diat. Die Süsswasser-Diatomaceen: von Dr. L. Rabenhorst. Leipzig, 1853.

Roper, Brit. Diat. Description of Three new British Species of Diatomaceæ. By F. C. S. Roper, in Quart. Journ. of Micr. Science, 1851.

Roper, Thames Diat. Observations on the Diatomaceæ of the Thames. By F. C. S. Roper, F.G.S. Transactions of the Microscopical Society of London, 1854.

Shad. Nat. Diat. Descriptions of new forms of Diatomaceæ from Port Natal. By G. Shadbolt. Transactions of the Microscopical Society of London, 1854.

THE BRITISH DIATOMACEÆ.

Genus 30. **MERIDION**, *Ag.*

Frustules cuneate, united into a filament, at first attached, at length free, and spiral; valves elongate, convex, furnished with transverse costæ, striated.

A close analogy exists between this genus and *Licmophora*. In both the frustules are cuneate, and adhere by their contiguous valves; consequently, during the process of self-division, a filament of a circular form becomes developed. In *Licmophora* the circular arrangement is speedily interrupted by the dichotomy of the stipes to which the united frustules are permanently attached; but in *Meridion*, the attachment being confined to the earliest stages of growth, and the frustules speedily becoming free, nothing interrupts the progress of the circular development save the imperfect adherence of the valves, or the occurrence of extraneous force. It is therefore not unusual to find the circuit completed, or the filament still farther extended into a coil of one or two superimposed circles, though, from the fragility of the band, it is ordinarily broken up into semicircles, or still smaller fragments, many consisting of not more than three or four frustules.

When first developed, the single or double frustules of *Meridion* bear a close resemblance to those of a *Gomphonema*; but the absence of a stipes serves to distinguish them from the stalked forms of that genus, and the peculiar markings of the valves offer sufficient means of discrimination in all other cases.

As we now enter upon the filamentous species, it may be necessary

to remark that the width of the filament equals the length of the frustule or valve measured along the suture or junction line, and that the breadth of the valve denotes the thickness of the filament.

1. **Meridion circulare,** *Ag.* Frustules on F. V. cuneate, truncate; V. cuneate, rounded at the larger extremity, gradually attenuated towards the other, which is slightly inflated and obtuse; costæ unequally distant, frequently interrupted; striæ obscure, 40 in ·001″. Length of frustule ·0013″ to ·0028″. v.v.

   β. Frustules with internal cells. v.v.

Ag. Consp. p. 40. Grev. B. F. p. 409. Harv. Man. p. 205. Ralfs, Ann. vol. xii. pl. xviii. 1. Hass. Alg. xcvi. 1–6. Quek. H. C. xii. 2. Kütz. Bacill. vii. 16; Sp. Alg. p. 10. Raben. Süssw. Diat. Taf. 1. *Meridion vernale,* Ag. Syst. p. 2. Ehr. Inf. xvi. 2. Prit. Anim. iii. 177. *Echinella circularis,* Grev. S. C. F. pl. 35. Var. β. *Meridion Zinckeni,* Kütz. Bacill. xvi. 8; Sp. Alg. p. 10. Raben. Süssw. Diat. Taf. 1. ad specim. quæ communicavit am. De Brébisson.

Fresh water: very frequent. Lulworth, Dorset, May 1849. Near Lewes, April 1850, March 1852, March and Dec. 1853. River Lee near Cork, April 1855, &c., *W. Sm.* Firle and Barcombe, Sussex, June 1842, *Mr. Jenner.* Aberdeenshire, Sept. 1847, *Dr. Dickie.* Var. β. Hornby, Lancashire, May 1852, *Mr. Geo. Smith.* Colin Glen near Belfast, *Dr. Dickie.* Kendal, March 1854, *Miss Hodgson.* (River Sorgues, Vaucluse; Fountain at Nismes; Royat, and Puy de Dôme, elev. 3000 feet, May and June 1854.)

There are few of our native Diatomaceæ more interesting to the observer than the present beautiful species, and few which more frequently present themselves to his notice. Its usual habitats are the sources of clear streams, especially in chalk or limestone districts; but it not unfrequently occurs in open streams or ditches, especially if the water be fresh and pure. It may always be found in its earlier stages of development attached to larger plants by its first-formed frustule by means of a minute gelatinous cushion; but the attachment is so evanescent that the slightest force seems sufficient to effect a separation, and in its more advanced condition the filaments are invariably detached.

Professor Kützing has removed the next species from the present genus on the ground of the former being attached or stipitate; but from what I have just said, it will be apparent that there exists no reason for such a separation. In truth, as far as my own observation extends, the facts are apparently the reverse of those upon which he relies,—*M. circulare* being at first attached, and *M. constrictum* usually free; I am however disposed to believe that in both cases an attachment exists, but only of an imperfect and temporary nature, and that in the second species named it is even more slight and evanescent than in the former. It not unfrequently happens, in still water, that the mucus which is produced during the process of self-division accumu-

lates around the dividing frustules and forms a considerable mass; in such cases the growing plant bears a close resemblance to *Gomphonema olivaceum* in a similar stage, and may be easily mistaken for it.

In var. β. we meet with a curious modification in the growth of the frustule, which has been regarded by some observers as characteristic of a distinct species. It will be afterwards seen that this view would lead, not unfrequently, to the removal of similar forms from the species to which they clearly belong, and from which the modification in question seems insufficient to warrant such a separation. A close examination of such frustules, especially in a living state, has led me to the conclusion that the appearance of a double wall of silex is owing to the formation within the original frustule of a second perfect cell, instead of the usual mode of division by which the original frustule is divided into two half-new cells, as described in the Introduction to the present work, Vol. I. p. xxiv. In the present case the central vesicle or cytoblast becomes enlarged without division, and secretes on its extension two new valves, which are pushed outwards until they lie in close approximation with the original valves. This process is not always repeated, the usual mode of self-division again recurs, and two valves are formed in the interior of this new cell according to the normal method; hence we have the appearance presented in var. β. of the present and following species, as figured in Plate XXXII. 277 β. and 278 β. This unusual method of development is not however sufficiently constant to warrant the separation of such frustules from the species in which it occurs, perhaps hardly sufficient to constitute a variety, as frustules in both the ordinary and abnormal states may be met with in the same gathering, and even in the same filament.

Plate XXXII. 277. Var. β. 277 β.

2. **Meridion constrictum,** *Ralfs.* Valve constricted towards the larger extremity, otherwise like the last. Length of frustule ·0006″ to ·0017″. v.v.

β. Frustule with internal cells. v.v.

γ. Frustule on S. V. nearly linear. Length ·0023″ to ·0030″. v.s.

Ralfs, Ann. vol. xii. pl. xviii. 2. Hass. Alg. xcvi. 7 & 9. Jenn. F. Tun. p. 206. Raben. Süssw. Diat. Taf. 1. *Eumeridion constrictum,* Kütz. Bacill. xxix. 81; Sp. Alg. p. 11.

Fresh water: frequent in boggy pools. Tunbridge Wells, April 1843, *Mr. Jenner.* Grassmere, Aug. 1853, *W. Sm.* Near Lancaster, Feb. 1852, *Mr. Johnson.* Davey Hulme near Manchester, *Prof. Williamson.* Near Aberdeen, March 1848, *Dr. Dickie.* Premnay Peat. (Berlin Fossil Earth, near Falaise, *M. De Brébisson.*) Var. β. Grassmere, Aug. 1853. Moanarone, county Cork, April 1855. River Spey, July 1854, *Dr. Gregory.* (Genolhac in the Cevennes, elev. 3600 feet. Puy du Cliergue, Mont Dore, elev. 5577 feet, *W. Sm.*) Var. γ. Grassmere, Aug. 1853, *W. Sm.*

In mode of growth and form of filament exactly like the last. I have never been able to verify the description given by Mr. Ralfs on the authority of Mr. Jenner, and copied by succeeding writers, that "the frustules stand erect like the staves of a tub, and when dry fall down and necessarily separate." In the specimens I have gathered in Westmoreland, and those received from M. De Brébisson, the circles are invariably arranged on a plane as in the last species; and although the adherence of the valves of the contiguous frustules appears less firm than in that species, there is no lack of filaments exceeding a semicircle, and not a few forming a complete round.

In my specimens the present is generally a smaller form than the last, and the F. V. of the frustule broader in proportion to the length. The same curious anomaly in the mode of growth is found in var. β. as noted under *M. circulare*, an additional proof that such peculiarities ought not to be adopted as a specific distinction. Var. γ. of our present form is probably a sporangial state of the plant, which escaped my recognition in the freshly gathered specimens.

Plate XXXII. 278. Var. β. 278 β. Var. γ. Supp. Pl. LX. 278 γ.

Genus 31. **BACILLARIA**, *Gmel.*

Frustules linear, straight, united into a filament, at first attached, at length free, coiled inwards; valves elongate, keeled, with a longitudinal line of puncta, keel eccentric.

The frustules of *Bacillaria* are those of a *Nitzschia*; but their adherence after self-division into a filament, frequently of considerable length, prevents the observer from placing them in the latter genus. When observed in a growing state, there is another peculiarity which at once serves to discriminate our native species, and that is the extraordinary motion with which the united frustules are endowed, and which is not seen in any other of the filamentous Diatomaceæ. This movement has been so well described by Mr. Thwaites in a communication to the Linnean Society (Proceedings, vol. i. p. 311), that I shall avail myself of his observations in the elucidation of the subject. Mr. Thwaites remarks that, "When the filaments have been detached from the plants to which they adhere, a remarkable motion is seen to commence in them. The first indication of this consists in a slight movement of a terminal frustule, which begins to slide lengthwise over its contiguous frustule; the second acts simultaneously in a similar manner with regard to the third, and so on

throughout the whole filament; the same action having been going on at the same time at both ends of the filament, but in opposite directions. The central frustule thus appears to remain stationary, or nearly so; while each of the others has moved with a rapidity increasing with its distance from the centre, its own rate of movement having been increased by the addition of that of the independent movement of each frustule between it and the central one. This lateral elongation of the filament continues until the point of contact between the contiguous frustules is reduced to a very small portion of their length, when the filament is again contracted by the frustules sliding back again as it were over each other; and this changed direction of movement proceeding, the filament is again drawn out until the frustules are again only slightly in contact. The direction of the movement is then again reversed, and continues to alternate in opposite directions, the time occupied in passing from the elongation in one direction to the opposite being generally about 45 seconds. If a filament while in motion be forcibly divided, the uninjured frustules of each portion continue to move as before, proving that the filament is a compound structure, notwithstanding that its frustules move in unison. When the filament is elongated to its utmost extent, it is extremely rigid, and requires some comparatively considerable force to bend it, the whole filament moving out of the way of any obstacle rather than bending or separating at the joints. A higher temperature increases the rapidity of the movement."

The motion here so accurately described is not essentially different from that noticeable in many of the free species of Diatomaceæ, the peculiarity being that it is here exhibited in numerous united frustules; when observed in a band of one hundred or more frustules, the singular appearances assumed by the filament under the action of so many individuals moving at one time in apparent concert, and another in opposition, never fail to excite astonishment.

The disposition of the coil in *Bacillaria* is the opposite of that in the last genus. In *Bacillaria* the curve takes an upward and inward direction, forming a roll as made by a sheet of paper, and not a spiral as is seen in the turns of a corkscrew.

The form arises in both cases from the unusual development of the valves, in *Meridion* the growth being greatest at one extremity of the

frustule, and gradually decreasing towards the other; while in *Bacillaria* the apposed sides or flanges of the valves throughout the entire length of the frustule are more developed on the exterior than the interior surface of the filament.

1. **Bacillaria paradoxa,** *Gmel.* Length of frustule ·0025″ to ·0042″. v.v.

Ehr. Inf. xvi. Prit. Anim. iii. 166 & 167. Hass. Alg. xciii. 10. Kütz. Bacill. xxi. 18. Bright. Inf. xv.

Brackish water. Near Wareham, Sept. 1849. Near Lewes, Aug. 1850, Feb., Aug., Oct. and Dec. 1852, Nov. 1853. Cork Harbour, April and June 1855, *W. Sm.*

A native of ditches near the sea, or in estuaries subject to marine influences, and not uncommon in such localities.

Plate XXXII. 279. Supp. Pl. LX. 279.

Genus 32. **HIMANTIDIUM,** *Ehr.*

Frustules linear, arcuate, united into a filament, at first attached, at length free, direct, and slightly arched; valves elongate, linear, arcuate, transversely striated.

A genus constituted by Ehrenberg, and in which are placed apart from *Fragilaria* those species in which the frustules are arcuate rather than direct. The separation is judicious, but the allocation of the names unfortunate, as the frustules of the species included under *Fragilaria* adhere more firmly than those which have been assigned to the present genus.

The separated frustules of *Himantidium* bear a close resemblance to those of *Eunotia*, and differ principally in their more frequent union into filaments. The terminal nodules of *Eunotia* are probably an appearance arising from the inflection of the valves at the point of junction, and are equally apparent in the present genus; nor is there any mark to distinguish the valve of the two genera, unless it be in the character of the striæ; which in *Eunotia* are radiate, and in *Himantidium* parallel.

There is much difficulty in the discrimination of species in *Himantidium*, the filaments in a growing state appearing precisely alike,

although the frustules which compose them may present great diversity in the outline of their valves. Nor in the latter particular do we find any very satisfactory or constant peculiarities; filaments whose frustules are composed of valves of a linear form, as in *H. Soleirolii*, being frequently found intermixed with others whose valves have terminal constrictions, as in *H. pectinale*, or one or more dorsal ridges, as in *H. undulatum*. Under such circumstances, it is difficult to say whether such forms are distinct species, or only varieties whose characters depend upon local or accidental circumstances. If regarded as of specific value, it is evident that the living condition of the plant will afford no certain means of identification, as the side view can alone be ascertained by an examination of frustules when the connexion of the valves has been dissolved; if, on the other hand, these diversities be esteemed as accidental variations, it will be equally difficult, in the case of fossil or prepared specimens, to determine from the valves alone whether we are dealing with one or several species. A wide examination and comparison of species in both conditions induces me to believe that the number has been unduly increased; and although, in deference to the authority of former observers, I have hesitated to curtail the list further than I have given it below, I am far from certain that (excluding *H. Williamsonii* as anomalous in form and habitat) the entire number of our native species might not be reduced to two, of which I should regard *H. pectinale* and *H. Arcus* as the typical forms;—the first characterized by a tenacious filament, and the second by the fragility of the connexion uniting the frustules, which are rarely found combined into a lengthened band. To the first type might be referred *H. undulatum*, *Soleirolii*, and *H. minus*, Kütz. To the second, *H. bidens*, *gracile*, and *majus*, *H. exiguum*, Bréb. (=*Eunotia gracilis*, W. Sm.), *H. denticulatum*, Bréb., the forms of *H. Arcus* described by Dr. Gregory under the names of *Eunotia bigibba* and *Himantidium bidens*, with numerous other varieties of outline which might be added to his list, together with many species of *Eunotia* which hold an intermediate place between the two genera, and are occasionally found in fragmentary filaments of from 2 to 8 frustules. The following list of species must therefore be considered as extended somewhat beyond the judgment of the author, to include the varieties described by other writers, while the figures given must be taken only as the more

ordinary forms, which include many others intermediate in size and outline. Conjugation and the formation of sporangial frustules have been observed by Mr. Thwaites and myself in one species of *Himantidium*.

SECT. I. Frustules forming a lengthened filament.

1. **Himantidium pectinale,** *Kütz.* Frustules on F. V. rectangular, straight; V. arcuate, linear, suddenly attenuated towards the extremities, which are slightly produced; striæ 27 in ·001″. Connecting membrane obscurely striated; striæ 48 in ·001″. Length of frustule ·0007″ to ·0058″. Breadth of valve ·0004″. v.v.

Kütz. Bacill. xvi. 11. ad sp. authen. quæ dedit am. De Brébisson. Raben. Süssw. Diat. 1. 1. C. · *Conferva pectinalis,* Dill. Conf. pl. xxiv. ad specim. authen. in herb. Grev. *Fragilaria pectinalis,* Ag. Syst. p. 7. Ag. Consp. p. 62. Lyng. Tent. lxiii. D.? English Botany, pl. 1611? Grev. B. F. p. 403. Harv. Man. p. 197. Ralfs, Ann. xii. 2. fig. 3 C. ad specim. authen. in herb. Jenn. Hass. Alg. xcv. 1 & 2 *b.* Quek. H. C. xii. 15. In conj. Thw. Ann. vol. xx. pl. xxii. A. *Eunotia depressa,* Kütz. Bacill. xxix. 39 & xxx. 2. *Himantidium minus,* Kütz. Bacill. xvi. 10. ad specim. authen. quæ dedit am. De Brébisson. *Conferva lucens,* Thore, et *C. bronchialis,* Roth., ad specim. authen. q. d. cl. Dr. Arnott.

Fresh water. Wareham, Mar. 1848. Cook's Bridge, Sussex, Jan. 1853, *W. Sm.* Tunbridge Wells, Oct. 1844, *Mr. Jenner.* Woodhead, Cheshire, May 1852, *Mr. T. Brittain.* Aberdeenshire, *Dr. Dickie.* Cader Idris, *Mr. Capron.* Dolgelly Earth, Lough Mourne, and Lough Island Reavey and Mull Deposits. (Falaise, *M. De Brébisson.* Pic de Sancy, Auvergne, elev. 6000 feet, June 1854, *W. Sm.*)

Plate XXXII. 280.

2. **Himantidium undulatum,** *W. Sm.* V. arcuate, constricted near the extremities, with a central inflation on the concave surface, and one or more dorsal elevations; striæ 22 in ·001″. Length of frustule ·0021″ to ·0058″. Breadth of V. ·0002″. v.v.

Fragilaria pectinalis, var. *β. undulatum,* Ralfs, Ann. vol. xii. pl. ii. fig. 3 *d.* Hass. Alg. xcv. 2 *d.* *Eunotia nodosa,* Ehr. Microg. passim.

Fresh water. Maam, Galway, July 1853. Lough Avaul, Co. Cork, June 1855, *W. Sm.* Sussex, *Mr. Jenner.* Newcastle, Co. Down, *Mr. W. Thompson.* Island of Arran, *Dr. Arnott.* Quenmore, Lancashire, *Mr. Johnson.* Haverfordwest, April 1854, *Mr. Phillips.* Lough Island Reavey and Mull Deposits, Dolgelly Earth, &c.

Plate XXXIII. 281, varieties 281 *a*, *a'*, and *a* 2.

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3. **Himantidium Soleirolii,** *Kütz.* V. linear, arcuate, extremities rounded; striæ 30 in ·001″. Length of F. ·0005″ to ·0042″. Breadth of V. ·0003″. v.v.

Kütz. Bacill. xvi. 9. ad specim. authen. quæ dedit. cl. De Brébisson. Raben. Süssw. Diat. 1. 3. *Fragilaria pectinalis,* var., Ralfs, Ann. vol. xii. pl. ii. 3. Hass. Alg. xcv. 3.

Fresh water. Wareham, Dorsetshire, Mar. 1848, *W. Sm.* In Scotland, communicated by *Mr. R. Beck.* Tunbridge Wells, Dec. 1842, *Mr. Jenner.* (Falaise, *M. De Brébisson.*)

This species so frequently occurs with internal cells, forming a variety similar to the one noted in *Meridion,* that Professor Kützing has included this peculiarity in his specific description. There is no doubt, however, of its being merely an accidental modification of cell-growth, as we frequently find in the same filament cells thus formed, and others following the normal mode of self-division.

Plate XXXIII. 282. and Pl. XXXV. 282 *f*.

Sect. II. Frustules rarely united into a filament.

4. **Himantidium Arcus,** *W. Sm.* F. V. frequently arcuate; valve arcuate, linear, or with dorsum slightly elevated, constricted towards the rounded extremities. Striæ 42 in ·001″. Length of frustule ·0012″ to ·0024″. v.v.

Kütz. Bacill. xxix. 43. ad specim. authen. quæ dedit cl. De Brébisson. Raben. Süssw. Diat. 1. 6. *Eunotia Arcus,* Ehr. Inf. xxi. 22? *Fragilaria pectinalis,* in conj. Thw. Ann. vol. 20. xxii. A.

Fresh water. Wareham, Sept. 1848 and Sept. 1851. Rackham, Sussex, Aug. 1853, *W. Sm.* Dolgelly Earth, Peterhead and Mull Deposits.

Plate XXXIII. 283. Suppl. Pl. LX. 283.

5. **Himantidium bidens,** *Ehr.* Valve arcuate, dorsum with two elevations constricted towards the truncate extremities. Striæ 27 in ·001″. Length of frustule ·0024″ to ·0031″. Breadth of V. ·0007″. v.s.

Kütz. Sp. Alg. p. 9. *Eunotia bigibba,* Kütz. Sp. Alg. p. 6? Greg. M. J. vol. 2. iv. 3.

Fresh water. Lough Island Reavey Deposit. Dolgelly Earth. Mull Deposit.

Plate XXXIII. 284.

6. **Himantidium gracile,** *Ehr.* Valve arcuate or direct, linear; extremities rounded, somewhat inflated or slightly recurved; striæ 27 in ·001″. Length of frustule ·0035″ to ·0065″. Breadth of valve ·0003″. v.v.

Kütz. Bacill. xxix. 40. ad specim. quæ dedit auc. De Brébisson.

Fresh water. Killicrankie, *Mr. P. Grant.* Dolgelly Earth. Lough Mourne, Lough Island Reavey, and Mull Deposits. (Fountain at Nismes; and Pic du Capucin, Auvergne, elev. 4567 feet, June 1854, *W. Sm.*)

Plate XXXIII. 285.

7. **Himantidium majus,** *W. Sm.* V. arcuate, dorsum elevated, extremities inflated and rounded; striæ 27 in ·001″. Length of F. ·0055″ to ·0075″. Breadth of valve ·0006″. v.s.

β. with two dorsal ridges.

β. *Himantidium bidens,* Greg. M. J. vol. 2. iv. 21.

Fresh water. Gap of Dunloe, Killarney, July 1855, *W. Sm.* Forfarshire, *Dr. Dickie.* Braemar, *Dr. Balfour,* Aug. 1854. Var. β. Mull Deposit, Dolgelly Earth, &c.

Differs little from *H. gracile,* save in its greater size and elevated dorsum, and is probably a sporangial form of it, or some other species.

Plate XXXIII. 286. Var. β. Supp. Plate LX. 286 β.

Sect. III. Filaments tenacious: marine.

8. **Himantidium? Williamsonii,** n. sp. Frustules direct; F. V. with central, terminal, and two intermediate inflations; central inflation with an acute angle, the others rounded; valves striated; striæ 20 in ·001″.

Marine. Dredged off the Island of Skye by *Mr. G. Barlee*; communicated by *Prof. Williamson.*

I have not been able, in the few specimens I possess of this interesting form, to obtain a S. V. of the frustules, and am in consequence in some doubt whether it might not be referred to another genus, probably to *Biddulphia,* to which the inflations on the surface of the valve and its marine habitat seem to ally it. The general appearance and tenacity of the filament are, however, those of the present genus, with which it must remain associated until a further examination confirms its present position or necessitates its removal.

Plate XXXIII. 287.

Genus 33. **ODONTIDIUM**, *Kütz.*

Frustules quadrangular, direct, united into a filament, at first attached, at length free; valves elliptical or cruciform, costate, costæ pervious or interrupted.

The frustules of *Odontidium* are distinguished from those of the last genus by their straight outline and conspicuous costæ, from those of *Fragilaria* by the latter character, and from those of *Denticula* by their more tenacious adherence and striated valves. It must however be acknowledged that there is little to separate the last-named genus from our present one, and I should be disposed to unite the two, were there not in the general habit of the living frustule characteristics which enable the observer to assign them to their respective genera; *Odontidium* often occurring in filaments of considerable length, and in some cases of no little tenacity; *Denticula* invariably in fragmentary portions rarely presenting more than two or four in union, and that union apparently of the feeblest kind. The surface of the valve in *Denticula* is also very distinctly striated, while in *Odontidium* the striæ, if present, are obscure, and elude detection by all but the most powerful and carefully-adjusted glasses. The appearance of minute teeth on the F. V. of the frustule, which arises from the terminations of the costæ, and from which Professor Kützing has derived the generic appellation of *Denticula*, is however far more conspicuous in some of the species belonging to *Odontidium*; and the two genera are so alike in their leading features, and their appellations so similar in meaning, that it may be left to future observers to consider whether they may not without much inconvenience be permanently united.

1. **Odontidium hyemale**, *Kütz.* V. elliptical, frequently attenuated towards the obtuse extremities; costæ pervious, from 5 to 12. Length of frustule ·0008″ to ·0014″.

Kütz. Bacill. xvii. 4. Raben. Süssw. Diat. ii. 4. *Fragilaria hyemalis*, Lyng. Tent. lxiii. E? Ralfs, Ann. vol. 12. pl. ii. 5. ex parte, et Hass. Alg. xcv. 5. ex parte, ad specim. authen. in herb. Jenn. *Fragilaria Confervoides*, Grev. B. F. p. 403. ad specim. authen. in herb. Grev. Harv. Man. p. 197. *Odontidium turgidulum*, Kütz. Bacill. xvii. 2. Raben. Süssw. Diat. ii. 6. *Fragilaria turgidula*, Ehr. Inf. xv. 13.

Fresh water. Dolgelly, Aug. 1843, *Mr. Ralfs*. Pentland Hills, April 1821, *Dr. Greville*. Near Dundee, 1824, *Rev. J. M^c Vicar*. Isle of Arran, 1851, *Dr. Arnott*. (Pic de Sancy, elev. 6000 feet. Grand Cascade, Mont Dore, elev. 4337 feet, June 1854, *W. Sm.*)

Plate XXXIV. 289.

2. **Odontidium mesodon,** *Kütz.* V. oval, frequently acuminate; costæ pervious, from 2 to 4. Length of F. ·0005″ to ·0011″. v.v.

Kütz. Bacill. xvii. 1. *Fragilaria hyemalis*, Ralfs, Ann. vol. 12. pl. ii. 5. ex parte. Hass. Alg. xcv. 5. ex parte.

Fresh water. Guernsey, Aug. 1848. Grassmere, Aug. 1853. Moanarone, County Cork, April 1855, *W. Sm.* Aberdeenshire, *Dr. Dickie*. Mealbank, Lancashire, April 1853, *Mr. G. Smith*. Ayrshire, *Dr. Arnott*, April 1854. Elchies, Bamffshire, *Dr. Gregory*, July 1854. (River Sorgues, Vaucluse. Genolhac in the Cevennes. Puy de Dôme, elev. 3000 feet. Mont Dore, elev. 3425 feet. Pic de Sancy, elev. 6000 feet, June 1854, *W. Sm.*)

Doubtfully distinct from the former, of which it may probably be the immature condition. *Odontidium turgidulum* of Kütz. Bacill. xvii. 2. appears to be an intermediate state.

Plate XXXIV. 288.

3. **Odontidium anomalum,** *W. Sm.* Filament tenacious; valves linear, constricted towards the rounded extremities; costæ pervious, 4 to 12. Length of frustule ·0005″ to ·0022″. v.v.

β. Frustules with internal cells.

W. Sm. Ann. ser. 2. vol. xv. pl. 1. 8. Greville, in Ann. ser. 2. vol. xv. pl. ix. 7, 8, 9.

Fresh water. Braemar, Aug. 1854, *Dr. Balfour*. (Genolhac in the Cevennes, elev. 4000 feet, June 1854, *W. Sm.*)

The presence of internal cells, a mode of growth which I have noticed in detail in my description of *Meridion circulare* and *Himantidium Soleirolii*, and which will again meet us in other cases, is found also to prevail in the present species. Both in the French and Scottish specimens, this variety is in fact the usual condition of the frustules, and the ordinary mode of self-division is only rarely to be met with: this has led Dr. Greville, in the paper above quoted, to regard this condition of the frustule as of specific value, and to doubt the propriety of regarding it as accidental or anomalous. It must, however, be remembered that but few specimens of the present species have as yet been discovered, and that a wider comparison will probably substantiate the view I have given, which harmonizes the character of this species with the ordinary Diatomaceous structure. *Himantidium Soleirolii* has sometimes

occurred to me with a majority of the frustules containing internal cells, and at other times every frustule in the filament has presented the usual character; the present species will, I have no doubt, occur under similar circumstances, and thus spare us the necessity of doing violence to the law which appears to regulate the self-dividing process throughout the Order.

Supp. Plate LXI. 376.

4. **Odontidium mutabile,** n. sp. Filament usually tenacious; V. oval, elliptical, or linear-acuminate; costæ marginal, distinct, 20 in ·001″. Length of frustule ·0002″ to ·0014″. v.v.

Diatoma tenue, Kütz. Bacill. xvii. 9 & 10? *Fragilaria turgidula, F. bipunctata,* et *F. diophthalmia,* Ehr. Inf. xv. 13?, 15?, 18? *Odontidium striolatum,* Kütz. Bacill. xxi. 20?

Fresh water: frequent. Plumpton, Sussex, March 1852. Near Lewes, April, June, and Nov. 1853, *W. Sm.* Peterhead and Lough Mourne Deposits. Raasay Earth, &c.

Exceedingly variable in size and outline of valve. This diversity has probably led to the formation of the various species noted in the synonymy above, none of which, from the slight details given by Professor Kützing, can be confidently referred to the present species, and yet all of which may probably be varieties of this sportive form. *O. mutabile* ordinarily presents a filament of considerable length, with the applied surfaces of the adjacent valves adhering so firmly, that the valves of each frustule separate under the action of an acid more readily than the cohering valves of contiguous frustules. Still, this is so far from being the invariable condition of the filament, that in some states of growth we find the frustules falling apart almost as readily as in *O. Tabellaria,* or partially separating as in *Diatoma,* thus giving occasion to those who regard their more or less tenacious connexion as of essential value, to constitute several species out of a single form in different stages of growth or decay.

Plate XXXIV. 290.

5. **Odontidium Tabellaria,** n. sp. Filament fragile; V. oval-acuminate, or lanceolate; costæ interrupted, delicate, 36 in ·001″. Length of frustule ·0003″ to ·0009″. v.v.

β. V. with a double inflation. v.s.

Staurosira construens, Ehr. Microg.? β. *Fragilaria binodis,* Ehr. Microg.?

Fresh water. Plumpton, Sussex, April 1851, *W. Sm.* Ormesby, Norfolk, Aug. 1853, *Mr. Bridgeman.* Horning, Norfolk, June 1854, *Mr. Wigham.* β. Ormesby, *Mr. Bridgeman.* Ben M^{c} Dhui, *Mr. P. Grant.* Peterhead Deposit. (Source of the Loiret near Orleans, June 1854, *W. Sm.*)

A very curious form, frequent in clear springs and mountain lakes, but overlooked from its minute size, and the close resemblance of the S.V. of its valve to small specimens of *Tabellaria flocculosa*; this aspect of the frustule differs, however, from the same in that species in its acuminate extremities and broader and more rounded inflation, and its mode of increase places it widely apart from the genus *Tabellaria*. Var. β. is a singular modification of growth, which frequently occurs intermixed with the other form. Whether the synonyms from the 'Microgeologie' belong to either or both these forms, I have no certain means of determining.

Plate XXXIV. 291. Var. β. 291 β.

6. **Odontidium? Harrisonii,** n. sp. Filament attached, of few frustules, which frequently adhere by their angles only; valve cruciform, angles rounded; costæ not reaching centre of valve, distinct, 13 in ·001″. Length of frustule ·0006″ to ·0018″. v.v.

β. A smaller form with more acute angles. Length of frustule ·0005″ to ·0009″. v.s.

Var. β. Roper, Journ. Micr. Sci. vol. ii. pl. vi. 6.

Fresh water. Near Hull, April 1852, Aug. 1849 and Jan. 1854, *Mr. R. Harrison*. Var. β. Aberdeenshire, *Dr. Dickie*. Burnham, Norfolk, Jan. 1854, *Mr. Brookes*. River Thames, Jan. 1854, *Mr. Roper*. Killiecrankie, August 1854, *Dr. Greville*. Lough Leven, *Dr. Gregory*. Lough Derg, Co. Clare, July 1855, *W. Sm. &c.*

The larger form has alone occurred in the locality where it was first discovered by Mr. Harrison; the smaller appears widely distributed, as it is sparingly present in almost every alpine or subalpine gathering with which I am acquainted. Though I have not seen a living specimen of the latter, yet it so closely resembles the larger form in everything but the greater acuteness of its angles, that I have not hesitated to regard it as a variety.

The position of *O. Harrisonii*, in a systematic arrangement, is a matter of doubt. The zigzag connexion of its frustules in the Hull specimens seems to point to *Diatoma* as its nearest ally, but the interrupted costæ remove it from that genus. Its structure and mode of growth are essentially different from *Tetracyclus*, to which the cruciform outline of its valve otherwise seems to approximate it. I should perhaps have placed it in *Staurosira* had I known the characters Ehrenberg assigns to that genus, but having only the figures of the 'Microgeologie' to guide me, I cannot be certain that Ehrenberg's definition would include my species. His outline of *Staurosira pinnata*, Microg. tab. v. ii. 24, is very like my Var. β.; but I do not see any figure in that work that can be regarded as representing the larger form of the present species. On the whole, being averse to constitute a new genus for the reception of a single species, I am disposed

to leave this interesting addition to our native forms for the present united with *Odontidium*, to which it seems allied through *O. Tabellaria* and *O. mutabile*.

Supp. Plate LX. 373. Var. β. Plate LX. 374.

7. **Odontidium? parasiticum**, n. sp. Frustules rarely cohering, attached by their extremities; valves direct, elliptical, and acute. Length of frustule ·0005″ to ·0009″. v.v.

β. Valve with a central constriction. v.v.

Fresh water: parasitic on *Nitzschia sigmoidea*. Queen's Park, Edinburgh, April and July 1854, *Dr. Greville*.

A minute form, which I place with doubt in the present genus, having never seen any approach to a filamentous union among its frustules. It is scarcely siliceous, and may prove eventually to be the early condition of some other species.

Supp. Plate LX. 375.

Genus 34. **DENTICULA**, *Kütz.*

Frustules quadrangular, or elliptical, direct, rarely united into filaments, free; valves elliptical, direct, striated, with pervious or interrupted costæ.

I have already said that the present genus is with difficulty distinguished from the last by any other character than that of the more imperfect tenacity of its filament; with no other is it likely to be confounded except *Diatoma*, and that only in a fossil or prepared state: when living, the coherence of the frustules at their angles is a character which at once distinguishes the latter genus.

1. **Denticula obtusa**, *Kütz.* Frustules linear, truncate; V. lanceolate, or linear, and attenuate towards the extremities, which are obtuse; striæ delicate, 36 in ·001″; costæ unequally distant, about 12 in ·001″. Length of frustule ·0006″ to ·0025″. v.v.

Kütz. Bacill. xvii. 14? Raben. Süssw. Diat. i. 8.

Fresh water. Penzance, *Mr. Ralfs*. Aberdeenshire, *Dr. Dickie*. Rescobie, Forfar, *Mr. P. Grant*. Ayrshire, May 1853, *Dr. Landsborough*. Braemar, *Dr. Balfour*; communicated by *Dr. Greville*, Sept. 1854.

The reference to Professor Kützing is made with some degree of hesitation,

as that author gives *Echinella obtusa* of Lyng. Tent. lxix. F., and *Frustulia obtusa* of Ag. Consp. p. 44, as synonyms of his species. Dr. Greville's Herbarium, containing original specimens of Lyngbye's and Agardh's species, which are identical, enables me to state that that species is different from the present, and in fact belongs to the genus *Diatoma*, the zigzag arrangement of the frustules being perfectly distinct, and the side view of the valve being slightly constricted near the extremities and inflated in the middle, precisely as may be seen in occasional specimens of *Diatoma elongatum*. If entitled to rank as distinct, Lyngbye's specimen must be placed near that species, and take the name of *Diatoma obtusum*. Kützing's figure of *Denticula obtusa* accords so nearly with the present, that I am disposed to think that he had our species before him, and must leave the reference to stand with a mark of doubt until the examination of an actual specimen enables me to determine the point. If the figure given by Rabenhorst be original, it would confirm the view here given, as it accords exactly with my species, and not at all with *Frustulia obtusa*, Ag., which is given as its synonym.

Plate XXXIV. 292.

2. **Denticula tenuis,** *Kütz.* Frustules linear, truncate; V. lanceolate, acute; striæ 40 in ·001″; costæ about 12 in ·001″. Length of frustule ·0006″ to ·0015″. v.v.

Kütz. Bacill. xvii. 8? *Denticula acuta*, Raben. Süssw. Diat. i. 7?

Fresh water. Plumpton, Sussex, April 1852. Larne, July 1853, *W. Sm.* Lancaster, Nov. 1853, *Mr. Johnson.* Mountains, Forfarshire, *Dr. Dickie.* Isle of Arran, *Dr. Arnott.* (Fountain at Nismes, May 1854, *W. Sm.*)

A small and more acute form than the last, but doubtfully distinct.

Plate XXXIV. 293.

3. **Denticula inflata,** n. sp. Frustules linear, or elliptical; V. oval, with rounded, or acute extremities; striæ 40 in ·001″; costæ about 12 in ·001″. Length of frustule ·0005″ to ·0007″. v.v.

Fresh water. Beachey Head, Sussex, Aug. 1852, *W. Sm.* (Château d'Eau, Montpellier, and Fountain at Nismes, May 1854, *W. Sm.*)

The smaller size and broader valve alone distinguish this species from the last two, with which it may be necessary eventually to unite it.

Plate XXXIV. 294.

4. **Denticula ocellata,** n. sp. Frustule linear, truncate, with conspicuous foramina on F. V.; valve linear, elliptical; striæ 40 in ·001″; costæ 10 in ·001″. Length of frustule ·0008″ to ·0011″. v.s.

Fresh water. Near St. Abb's Head, July 1855, *Dr. Balfour.*

I had the pleasure of detecting the above species during the printing of the present sheets, in a gathering sent me by Dr. Gregory of Edinburgh. The frustules on the F. V. closely resemble small specimens of *Ephithemia Argus*, but the valve is wholly different. The extremities of the costæ or canaliculi appear as circular foramina on the F. V., and the costæ of the S. V. also give an ocellated appearance to the valve, which serves to distinguish it from any other species in the present genus

5. **Denticula sinuata,** n. sp. Frustule linear, truncate; V. lanceolate, margin with three undulations; striæ delicate, 52 in ·001″; costæ interrupted, 10 in ·001″. Length of frustule ·0008″ to ·0015″. v.v.

"*Denticula sinuata,*" ad specimina sub hoc nomine quæ misit am. Thwaites, Oct. 4, 1848.

Fresh water. Near Bristol, *Mr. Thwaites.* Wray, Nov. 1851, *Mr. Geo. Smith.* Killiecrankie, *Mr. P. Grant.* Dryburgh, March; Pentland Hills, July 1854, *Dr. Greville.* Cumbrae Island, Feb. 1854, *Mr. R. Hennedy.*

Plate XXXIV. 295.

Genus 35. **FRAGILARIA,** *Lyng.*

Frustules linear, straight, united into a filament, free or attached, direct; valves linear, or elliptical, direct, striated.

The filaments of the present genus are less fragile than those of any previously described, and in this respect the name, as I have elsewhere remarked, has been unfortunately retained for species which had better have been ranged under another appellation. In fact, nothing can be more embarrassing than the changes to which the various species originally described by Lyngbye under the name of *Fragilaria* have been forced to undergo. Only one of the eight species he has placed in this genus will be found below, and that one has been restored to its position in opposition to the authority of Professor Kützing, who has excluded it altogether from the Diatomaceæ.

It must be admitted that the species described by Lyngbye are far too heterogeneous in their characters to be united under one genus, and that their separation was imperative in the present more advanced state of the science; still it is much to be regretted that

their rearrangement should not have been made with more regard to the original nomenclature, and the signification of the terms employed kept more strictly in view.

1. **Fragilaria capucina,** *Desm.* Valves linear, cuneate at the subacute extremities; striæ 40 in ·001″. Length of frustule ·0012″ to ·0025″. v.v.

Var. β. Valves attenuate towards the obtuse extremities. v.v.

Var. γ. Frustules subsiliceous, adhering imperfectly. Length ·0033″ to ·0042″. v.v.

Kütz. Bacill. xvi. 3. Raben. Süssw. Diat. i. 2. *Fragilaria Rhabdosoma,* Ehr. Inf. xv. 12. Prit. Anim. iii. 173, 174. Ralfs, Ann. vol. 12. pl. ii. 4. Hass. Alg. xcv. 6. ad specim. authen. in Herb. Jenn.

Fresh water: frequent. Lewes, Nov. 1851, Aug. 1852 and Aug. 1853. River Lee near Cork, April 1855, &c., *W. Sm.* Glen Dee, Aberdeenshire, *Dr. Dickie.* Quenmore, Lancashire, April 1852, *Mr. Johnson.* Lough Mourne and Peterhead Deposits, &c.

Var. β. Well at Passage near Cork, August 1855, *W. Sm.* &c.

Var. γ. Rosthern Mere, Cheshire, September 1855, *Dr. Arnott.*

This species is common at all seasons in still and running waters, but seldom in much quantity or in an unmixed state. Its habit is stiff and unbending; its colour under the microscope clear and translucent, and when dry lustrous. Its filaments often resemble those of the last species, but usually the front view of the frustule is narrower, and the valves linear and more finely striated. Vars. α. and β. are frequently intermixed. Var. γ. has only occurred to me in Dr. Arnott's gathering, and is a very peculiar and probably a sporangial condition. When dry the frustules in this variety shrink, except in the central and extreme portions, and remain loosely attached by these parts only.

Plate XXXV. 296.

2. **Fragilaria virescens,** *Ralfs.* V. linear or elliptical, suddenly attenuated towards the produced extremities, which are obtuse; striæ 44 in ·001″. Length of frustule ·0005″ to ·0027″. v.v.

β. Frustules cohering by their angles only.

Ralfs, Ann. vol. 12. pl. ii. 6. Kütz. Bacill. xvi. 4. Raben. Süssw. Diat. i. 1. *Fragilaria pectinalis,* Ehr. Inf. xvi. 1. Prit. Anim. iii. 176. *Fragilaria hyemalis,* Ag. ad specim. authen. in Herb. Grev. Var. β. *Diatoma pectinale* et *Diatoma tenue,* Kütz. ad specim. authen. quæ dedit cl. De Brébisson. *Diatoma virescens,* Hass. Alg. xcv. 7. 8.

Fresh water. Moanarone, County Cork, April 1855, *W. Sm.* Tunbridge

Wells, Dec. 1842 and Mar. 1843, *Mr. Jenner*. Aberdeenshire, *Dr. Dickie*. Lanarkshire, October 1855, *Dr. Arnott*. Fell End, Lancashire, May 1851, *Mr. Johnson*. Near Haverfordwest, April 1854, *Mr. Okeden*. Near Ulverstone, Aug. 1854, *Miss E. Hodgson*. Lough Mourne Deposit. Marl, Co. Down. Premnay Peat and Mull Deposit. Var. β. Ashdown Forest, March 1844, *Mr. Jenner*. (Falaise, *M. De Brébisson*. Genolhac in the Cevennes, elev. 3600 feet. Pic de Sancy, elev. 6000 feet, June 1854, *W. Sm.*)

This species, first collected in Britain by Mr. Jenner, and described by Mr. Ralfs, is correctly outlined by Ehrenberg under the name of *F. pectinalis*; yet, as he describes his species as striated, and as it is certain that with the defective instruments he employed he could not have detected the transverse striæ on the true *F. virescens*, we must conclude that he examined specimens intermixed with *Himantidium pectinale*, and remarking the notable striæ on the frustules of the latter, concluded that they belonged to the present species.

The ordinary condition of *F. virescens* is undoubtedly that of a filament of considerable tenacity, the frustules, like those of *Odontidium mutabile*, parting in the centre, rather than separating by the adjacent surfaces; but in certain stages of growth, or under peculiar circumstances of development, this character appears to be lost, and partial dismemberment takes its place, the frustules still cohering with considerable tenacity, but only by their alternate angles, as in other genera hereafter to be described. In this condition our present plant has been transferred by Hassall and Kützing to *Diatoma*, its alliance with which genus we regard as accidental, the normal condition of the filament being characterized by a tenacity wholly unknown in *Diatoma*.

Plate XXXV. 297. Var. β. Plate XXXV. 297 *f'*.

3. **Fragilaria striatula,** *Lyng.* Valve linear, somewhat attenuated towards the obtuse extremities; striæ 64 in ·001″. Length of frustule ·0009″ to ·0016″. v.v.

Lyng. Tent. lxiii. A. *Grammonema Jurgensii*, Ag. Consp. p. 63. Ralfs, Ann. vol. 13. pl. xiv. 5. *Fragilaria aurea*, Car. Grev. B. F. p. 403. Harv. Man. p. 197. ad specim. authen. in Herb. Grev. *Fragilaria diatomoides*, Grev. B. F. p. 403? Harv. Man. p. 198? *Grammatonema striatulum*, Kütz. Sp. Alg. p. 187.

Marine. Coast of Sussex, Sept. 1850, April and May 1852, *W. Sm.* Appin, *Capt. Carmichael*. Frith of Clyde, April 1853, *Dr. Landsborough*.

Though less firmly siliceous than many others of the filamentous Diatomaceæ, the present species undoubtedly belongs to this Order, and cannot be located with the *Desmidieæ*, as has been done by Professor Kützing in the 'Species Algarum.' The behaviour of the frustules under nitric acid is similar to that of the other filamentous species, and the cell-wall resists the action of fire; the frustules, though losing somewhat of their rigidity under the action of the latter agent, still retain sufficient of their form and character to show that silex must be largely combined with their substance. The figure we

have given in Plate XXXV. 298. represents the filament after being burnt, the elliptical outline of the frustules on the F. V. arising from the shrinking of the cell-wall. The present species often secretes during self-division a considerable amount of mucus, which gives to the mass of filaments a gelatinous character; at other times, this character is altogether absent, and the filament has precisely the appearance of *F. virescens*, differing from the latter only in its darker and more golden colour, and its habitat, which is exclusively marine. The S. V. of the valve is also nearly that of the species just mentioned, but may be known by its more rounded extremities and its far more delicate striæ. All the writers who have described this plant speak of the filaments as attenuated; I can only say that an attentive examination of the species, gathered in various localities and at distant intervals, has failed to satisfy me that any such character is to be found. I have already stated (Introd. vol. i. p. xxvi) that an occasional inequality or slight enlargement in size of the frustules may sometimes be noticed in the filamentous Diatomaceæ; but I have never detected anything resembling a gradual increase or diminution in the diameter of the filament, and am disposed to believe that such a condition would be at variance with the laws of growth which prevail throughout the Order, and that the semblance of such a condition in the present species arises from the position of the filament, an oblique direction giving an appearance of attenuation which has no existence in fact. The crenated outline of the margin of the dried filament, as represented by Mr. Ralfs, is also due to the shrinking of the cell-wall. In a fresh and living state the outline of the frustule on a F. V. is exactly linear; but when dried, especially after death or incipient decomposition, the extremities collapse, and the frustules become partially disconnected: hence the appearance which has been described and figured by this careful and trustworthy observer.

Plate XXXV. 298.

4. **Fragilaria undata,** n. sp. Filaments imperfectly tenacious; frustules frequently cohering by their angles; valve oval, acuminate; striæ 42 in ·001″. Length of frustule ·0006″ to ·0008″. v.v.

β. Valve linear, acuminate. Length of frustule ·0008″ to ·0012″. v.v.

γ. Valve constricted in the centre. Length of frustule ·0008 to ·0021″. v.v.

Var. γ. *Odontidium Tabellaria*. "Sporangial," Greg. M. J. vol. ii. pl. iv. 22.

Fresh water. Var. γ. Mull Deposit. (The three forms in River Mortes, Mont Dore, elev. 4066 ft., June 1854, *W. Sm.* Near Christiania, *Dr. Arnott.*)

Living specimens which I collected in the French locality above mentioned have enabled me to assign the present species to the genus *Fragilaria*, with which its mode of growth, filamentous character, and delicately striated valves ally it more closely than with any other genus.

Supp. Plate LX. 377.

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Genus 36. **EUCAMPIA**, *Ehr.*

Frustules cuneate, quadrangular or oblong, united into a spiral filament; valves dotted, elliptical.

The cuneate form of the frustules, and their development into a spiral filament, ally the present genus with *Meridion*; but the absence of costæ, with the broader form of the frustules and valves, place it in close proximity to the last. Neither of the undermentioned species have occurred to me in a living state; but the structure of the frustules, their presence with other familiar forms in a habitat exclusively marine, and their similar behaviour under the action of nitric acid, leave no doubt on my mind of their true Diatomaceous character, and forbid their relegation to the family of the Desmidieæ, a course which has been adopted by Professor Kützing in apparent ignorance of their true character and habitat.

1. **Eucampia Zodiacus**, *Ehr.* Valve elliptical, with a deep central excavation; F. trapezoidal. Length of F. about ·0014″. v.s.

Kütz. Bacill. xxi. 21; Sp. Alg. p. 191. Prit. Anim. xiii. 43.

Marine. Stomach of *Pecten maximus*. Coast of Sussex, Feb. 1853, and March 1854, *W. Sm.*

Plate XXXV. 299. Supp. Plate LX. 299.

2. **Eucampia Britannica**, n. sp. V. plane; F. oblong. Length of F. about ·0026″. v.s.

Marine. With the last, March 1854, *W. Sm.*

Supp. Plate LXI. 378.

Genus 37. **ACHNANTHES**, *Bory.*

Frustules geniculate, united into a filament, which is stipitate or attached; valves striated, unsymmetrical, the lower with a longitudinal and transverse line, and central and terminal nodules, the upper with a longitudinal line only.

The want of symmetry in the valves of their frustules is a character

which sufficiently distinguishes this and the following genus; while the presence of a stipes of more or less perfect development separates *Achnanthes* from its ally. The peculiar form, conspicuous size, and general diffusion of the several species of the present genus place them among the most singular and interesting of the Diatomaceæ, and have attracted the attention of all observers; still but very little is known of the circumstances which control their development, and conjugation has been noticed in one species only, and that by myself alone. The anomalous form of the valves, and the exceptional character of their markings, I am wholly unable to explain; the additional strength given to the lower valves by the presence of nodules and a transverse band of silex being apparently uncalled for by any peculiar stress or demand upon this portion of the frustule.

Some confusion has been introduced into the genus by adopting the length of the stipes as a specific character. This feature, though constant in some, varies greatly in other species, and ought not therefore, in the latter cases, to be regarded as an important distinction; its comparative length or even presence in such species wholly depending upon the stage of growth at which the filaments have arrived. Nor is the length of the filament, into which the united frustules cohere, a satisfactory criterion, the coherence being apparently dependent upon accidental circumstances, and varying with the habitat and season. The form and striation of the valve are more certain and constant characters, and these, though subject to slight modifications, are our best guides in the discrimination of species. The habit of growth in the stipitate species will also be found an important aid, the filaments being sometimes scattered over the larger Algæ to which they are affixed, sometimes springing from a point around which their stipes cluster in considerable numbers. It will be seen from the figures given, that the connecting membrane in the present genus is usually delicately striated, a character which has been before noticed in *Himantidium*, and will be found in others of the filamentous Diatomaceæ.

1. **Achnanthes longipes,** *Ag.* Filament of few frustules, from 2 to 16; V. linear-elliptical, obtuse, with a slight central constriction, costate; costæ unequally distant, from 6 to 12 in ·001″; striæ

moniliform, 27 in ·001″. Length of frustule ·0019″ to ·0072″. Stipes usually clustered, from ·0006″ to ·0192″ in length. v.v.

β. V. oval or broadly elliptical. v.v.

γ. Frustule deeply geniculate. v.s.

Ag. Syst. p. 1. Ag. Consp. p. 58. Eng. Bot. 2nd ed. pl. 2560. Grev. B. F. p. 404. Harv. Man. p. 200. Ehr. Inf. xx. 1. Ralfs, Ann. vol. 13. pl. xiv. 7. ad specim. authen. in Herb. Jenn. Kütz. Bacill. xx. 1. Quek. H. C. xii. 8. *Conferva stipitata*, Eng. Bot. 1st ed. pl. 2488. *Achnanthes Carmichaelii*, Grev. B. F. p. 404. Harv. Man. p. 200. Kütz. Bacill. xx. 2. *Achnanthes brevipes*, Kütz. Bacill. xx. 9.

Marine. Parasitic on other Algæ. Poole Bay, June, and in conjugation, July 1849. Jersey, July 1852. Larne, Ireland, July 1853. Newhaven, Sussex, Oct. 1853, *W. Sm.* Southampton, April 1844, *Mr. Jenner*. Southampton, July 1812, *Miss Hill* and *Miss Biddulph*; communicated by *Mrs. Griffiths*. Var. β. Seaford, Sussex, April and Sept. 1851, and in conjugation, March 1852, *W. Sm.* Var. γ. Newhaven, Sussex, July 1843, *Mr. Jenner*. (Mediterranean near Marseilles. Salt Pits near Agde, May 1854, *W. Sm.*)

I have included under the above both *A. Carmichaelii*, Grev., and *A. brevipes*, Kütz., neither species, judging from the figures in the 'Bacillarien,' having any distinctive characters save the greater or less length of the stipes; while in all my various specimens this feature is of the most variable kind, frustules nearly sessile, and others with a stipes ten times their own length occurring in the same cluster. With regard to Var. β. I am in doubt whether it should not be ranked as distinct, the broadly elliptical form of the frustule being tolerably constant, and the habit of growth more diffuse and scattered than in my other specimens. It has also maintained its characters unchanged for several successive seasons, disappearing and being again produced in the same pool without any apparent change in its form or habit; at the same time, forms intermediate between it and the most linear and clustered specimens of *A. longipes* have so often presented themselves in the same and other localities, that I do not feel myself warranted in elevating the Seaford plant into a distinct species.

The presence of costæ is alone sufficient to distinguish *A. longipes* and its varieties from the other species of this genus. These costæ appear to be thickenings on the under surface of the siliceous valve, and not, as in others of the *Diatomaceæ*, confluent beaded striæ; the latter extending, as is ordinarily the case, over the entire surface of the valve, though the regularity of their arrangement is much obscured in the present species by the interference produced by the underlying costæ.

Plate XXXV. 300. Plate XXXVI. 300. Var. β. Plate XXXVI. 300 β. Var. γ. Plate XXXVI. 300 γ.

2. **Achnanthes brevipes,** *Ag.* Filaments containing from 2 to several hundred frustules; V. linear or oval, attenuated or acute,

rarely constricted; striæ moniliform, 20 in ·001″. Length of frustule ·0006″ to ·0028″. Stipes never exceeding the length of the frustule, solitary or subgregarious. v.v.

Ag. Syst. p. 1. Ag. Consp. p. 59. Grev. S. C. F. pl. 295. Grev. B. F. p. 404. Harv. Man. p. 199. Ehr. Inf. xx. 2. Prit. Anim. iv. 199–202. Ralfs, Ann. vol. 13. pl. xiv. 9. ad specim. authen. in Herb. Jenn. Raben. Süssw. Diat. viii. 4. *Echinellc stipitata*, Lyng. Tent. lxx. B. ad specim. authen. in Herb. Grev. *Achnanthes salina*, Kütz. Bacill. xx. 5. et *A. intermedia*, Kütz. Bacill. xx. 6. ad specim. authen. quæ dedit am. De Brébisson.

Marine or brackish water. Coast of Sussex, frequent. Pevensey, Sept. 1850. Beachey Head, April; Lancing, Aug.; Bexhill, Oct.; and Newhaven, Dec. 1852, *W. Sm.* Lancing, July 1843, *Mr. Jenner.* Torbay, *Mrs. Griffiths.* (Mediterranean near Marseilles, and near Montpellier, May 1854, *W. Sm.*)

An original specimen of Lyngbye's in the Herbarium of Dr. Greville enables me to refer this species to *Echinella stipitata*, while the specimens received from M. De Brébisson satisfy me that *A. salina* and *A. intermedia* of the 'Bacillarien' are also identical with the present. Some confusion appears to have arisen from the fact that this species at one time forms a long filament, and at another presents itself only in very short standard-shaped fronds; no distinction in the form or structure of the valve is however to be detected between the two, and the varieties, if such they may be called, are often found intermixed in the same gathering. Mr. Ralfs observes that "the lateral view is more frequently constricted than in *A. longipes*," but my own observation fails to confirm this. Usually the S. V. appears almost linear, becoming rapidly attenuated towards the somewhat acute ends, and not unfrequently the valve is inflated at the centre, assuming an oval outline, with the extremities slightly produced: a slight constriction is no doubt occasionally to be detected, but such an outline seems to me to form the exception rather than the rule.

Plate XXXVII. 301. Forming a long filament, Plate XXXVII. 301 *β*.

3. **Achnanthes subsessilis,** *Kütz.* Filaments of few frustules, rarely exceeding 4; valve elliptical, extremities rounded; striæ moniliform, 24 in ·001″. Length of frustule ·0013″ to ·0021″. Stipes very short, solitary. v.v.

Kütz. Bacill. xx. 4. Raben. Süssw. Diat. viii. 3. Ehr. Inf. xx. 3. Ralfs in Ann. vol. 13. pl. xiv. 10. ad specim. authen. in Herb. Jenn.

Fresh or brackish water: rare. Near Lewes, Oct. 1851, *W. Sm.* Scotland, *Dr. Greville.* Pilling Marsh, Lancashire, Aug. 1852, *Mr. Johnson.* Wales, *Mr. Ralfs*; communicated by *Mr. Jenner.*

Undoubtedly distinct from the last, with which it has sometimes been con-

founded. Its distinctive characters are an abbreviated stipes, which generally assumes the form of a mere cushion, and never reaches half the length of the frustule, and elliptical valves with rounded, and not attenuate, extremities. It is a much rarer plant than either of the former; or, being more inconspicuous, has been more frequently overlooked. A remarkable instance of the abnormal development adverted to under *Meridion circulare* has presented itself in the present species, an example of which is figured in Plate XXXVIII. 302*. Here, the formation of a cell interior to the original one has proceeded through several successive stages, and the result is a compound frustule, consisting of the mother-cell and a number of included cells, each successive development being embraced by the others previously formed.

Plate XXXVII. 302.

4. **Achnanthes exilis,** *Kütz.* Filaments from 2 to 50 frustules; V. linear-lanceolate, with obtuse extremities, occasionally somewhat produced; striæ very faint. Length of frustule ·0006″ to ·0018″. Stipes very variable in length, subgregarious or solitary. v.v.

Kütz. Bacill. xxi. 4. ad specim. quæ dedit am. De Brébisson. Ralfs, Ann. vol. 13. pl. xiv. 12. ad specim. quæ dedit cl. Auctor. Hass. Alg. c. 5. Raben. Süssw. Diat. viii. 1. *Achnanthes minutissima*, Ralfs, Ann. *l. c.* fig. 11. Hass. Alg. *l. c.* fig. 4. ad specim. authen. in Herb. Jenn.

Fresh water. Near Lewes, Sept. 1852, March 1853. Parasitic on the stipes of *Gomphonema geminatum*, Galway, July 1853; and Grassmere, Aug. 1853, *W. Sm.* Parasitic on the stipes of *Gomphonema naviculoides* in the tank of the Victoria regia, Edinburgh Botanic Gardens, Sept. 1853, *Dr. Greville.* Monkland Canal near Glasgow, Oct. 1853. *Mr. R. Hennedy.* Saltcoats, Ayrshire, Jan. 1854, *Dr. Arnott.* On *Gomphonema geminatum*, Dolgelly, *Mr. Ralfs.* Wray, Lancashire, July 1850, *Mr. Geo. Smith.* Cheshunt, *Mr. Hassall*; communicated by *Mr. Jenner.* (Well near Marseilles, May 1854, *W. Sm.*)

I am unable to find constant characters in the numerous British specimens in my possession by which to constitute two species of the above, and feel constrained to regard *A. minutissima* of Ralfs as a mere state or variety of the present plant. It will be seen, by a reference to the figures given by Mr. West, how sportive in habit of growth and length of filament are the specimens with which I furnished him, and yet each extreme may not unfrequently be found in close neighbourhood on the plant which serves as their support.

The length of the stipes, upon which Mr. Ralfs seems mainly to rely, I cannot accept as a specific character in the present species, as it seems to me to be chiefly dependent upon the stage of growth. Thus Mr. Ralfs says, that in *A. minutissima* "the stipes is not longer than the frustule," while in *A. exilis* "the stipes exceeds the frustule in length." Now, in the specimens

from Falaise, I find the former with a long, and the latter with an abbreviated stipes. Nor do I think the form of the V., though varying from lanceolate with acute ends, to linear-lanceolate with obtuse and somewhat capitate extremities, any certain criterion, as I find these several forms intermixed in the same gathering. On the whole, I am disposed to believe that we have in Britain, as far as has hitherto been observed, but one species, though this is exceedingly variable, and in its extreme conditions may easily be mistaken for distinct species. I have not been able to resolve the striæ upon the present species sufficiently to estimate their number; there are, however, indications in the colour of the dry valve which convince me of their presence.

Plate XXXVII. 303 and 303 *β*.

Genus 38. **ACHNANTHIDIUM**, *Kütz.*

Frustules geniculate, rarely united into a filament, free; valves striated, unsymmetrical.

This genus, which for the present includes several species of somewhat doubtful character, was constituted by Professor Kützing to receive those forms which, with an evident resemblance to *Achnanthes*, are rarely united into a lengthened filament, and have no stipes or other attachment to a foreign body. The genus *Diadesmis* of Ehrenberg is a near ally, and in regard to some of the minute forms, where the geniculate character of the frustule is with difficulty discerned, it is almost impossible to decide to which of the genera we ought to refer our specimens. I have adopted Kützing's genus, because our two most distinct species, viz. *A. lanceolatum* and *A. coarctatum*, evidently belong to it. *Cocconeis Thwaitesii*, W. Sm. (see Synopsis of British Diatomaceæ, vol. i. p. 21), is another species, which has been placed in the present genus by its discoverer, M. De Brébisson: if it should prove to be a perfectly free form, this allocation must be admitted, and the species described in a future edition as *Achnanthidium flexellum*, Bréb.

1. **Achnanthidium lanceolatum**, *Bréb.* Filament of numerous frustules, from 2 to 100; valves elliptical; upper with a median line and central nodule; the nodule in lower (?) dilated at one side into two processes, extending to the suture; striæ 40 in ·001″.

Length of frustule ·0004″ to ·0008″. Breadth of valve ·0002″ to ·0003″. v.v.

Bréb. in Kütz. Sp. Alg. p. 54. ad specim. authen. quæ communicavit cl. inventor.

Fresh water: very generally distributed in subalpine districts. Beachey Head, Sussex, Aug. 1851. Portisham Spring, Dorsetshire, Sept. 1854. Moanarone, Co. Cork, Aug. 1855, &c., *W. Sm.* Aberdeenshire, *Dr. Dickie.* Ayrshire, *Dr. Landsborough.* Kendal, and Ulverstone, March 1854, *Miss E. Hodgson.* Cumbrae, May 1854, *Mr. Hennedy.* (Puy de Dôme, elev. 3000 feet, June 1854, *W. Sm.* Falaise, *M. De Brébisson.*)

Plate XXXVII. 304.

2. **Achnanthidium coarctatum,** *Bréb.* Filament of few frustules, 2 to 6; valves elliptical, with a central constriction and slightly attenuate ends, striated; upper with a median line and distinct stauros; under with median line only; striæ 40 in ·001″. Length of frustule ·0005″ to ·0015″. v.v.

Bréb. in lit. cum specim. authen. Jan. 1852. W. Sm. Ann. ser. 2. vol. 15. pl. i. 10. *Stauroneis constricta,* Ehr. in Kütz. Bacill. xxix. 19?

Fresh water. Grassmere, Aug. 1853, *W. Sm.* Cramond near Edinburgh, Oct. 1855, *Dr. Arnott.* Haverfordwest, April 1855, *Mr. Okeden.* (Basaltic Cave at Royat, in the Auvergne, June 1854, *W. Sm.*)

Supp. Plate LXI. 379.

3. **Achnanthidium microcephalum,** *Kütz.* Filament of 2 or 4 frustules; valves elliptical-lanceolate, constricted towards the extremities, with a median line, and central and terminal nodules; striæ obscure. Length of frustule ·0004″ to ·0006″. v.v.

Kütz. Bacill. iii. 13 & 21; Sp. Alg. p. 54. ad specim. authen. quæ misit cl. De Brébisson.

Fresh water. Aberdeenshire, *Dr. Dickie.* (Falaise, *M. De Brébisson.*)

I place this form doubtfully in the present genus, for not only are the valves apparently symmetrical, but the geniculate character of the frustule is often absent: the minuteness of the species precludes any very certain diagnosis, and I yield to the authority of M. De Brébisson, with whose specimens Dr. Dickie's very accurately agree.

Supp. Plate LXI. 380.

4. **Achnanthidium lineare,** *W. Sm.* Filament of 2 to 4 frustules; valves linear, rounded; upper with median line only; lower with

median line, and central and terminal nodules; striæ obscure. Length of frustule ·0005″. v.v.

W. Sm. Ann. ser. 2. vol. xv. pl. i. 9. July 1854.

Fresh water. Lasswade near Edinburgh, *Dr. Greville.* (Vaucluse, May 1854, *W. Sm.*)

Supp. Plate LXI. 381.

Genus 39. **RHABDONEMA,** *Kütz.*

Filaments compressed, continuous, attached, or stipitate; frustules annulate, indefinite; annuli plane, cellulate on their circumference, forming internal septa; valves elliptical, striate, with a median line, striæ moniliform.

The present genus first presents us with a mode of increase in the dimensions of the frustule, which we shall afterwards find occurring in other filamentous forms, and which has caused no little perplexity to the student of these organisms. As this phænomenon has hitherto frequently escaped the notice of writers on the Diatomaceæ, and the appearances it produces been misunderstood, it will be necessary to enter into a somewhat lengthened explanation.

In the species in which this mode of increase occurs, the valves are similar in character to those of the other Diatomaceæ with which we are familiar, and are formed during self-division in the manner already described (Introduction, vol. i. Section V.); but instead of the usual repetition of the process of valve-formation, there detailed, we are here presented with a subsequent intervalvular development, which, not confined to the exterior of the frustule, projects a plate of silex into its interior, forming a septum or partition extending towards, but not reaching, the centre of the cell, and appearing as a compressed rim, or *annulus* of silex, whose outer or larger circumference follows the exterior outline of the frustule, and whose inner edge bounds the free space, which serves as a channel of communication between the chambers into which the cell is thus divided. This process is either simultaneous, and the frustule *definite*, or successive, and the frustule *indefinite*. In the first case, the annuli of silex are formed during the production of the valves in the progress of

self-division, and on every repetition of such production; while in the second case, the formation of the annuli is continued after the production of the valves, and is repeated an uncertain number of times before the recurrence of a new valve-production. The interior of the frustules in both cases is divided by the annuli into chambers, communicating with each other by the free spaces left between the inner margins of the annuli, or by perforations in the septa; consequently the frustules, although apparently complex in structure, still remain unicellular as in the more ordinary forms. This may easily be seen by the distribution of the endochrome in the living, or its aggregation into a simple mass in the dead frustule. It is to be noted, however, that in the case of those species in which this increase is indefinite, we do not find the regularity of operation which characterizes self-division in other species; the formation of the new valves taking place with apparent indifference at any part of the elongated frustule, that is to say, between any two of the annuli. This gives a want of symmetry to the appearance of these forms, and enables the observer to detect their true character. On a front view, the septa, which project into the cell, are seen as costæ, extending from the margin towards the centre of the frustule; and on a side view, the spaces intervening between the convex interior edges of the septa, or the perforations in the septa when such exist, appear as circular or elliptical outlines traced upon the inner surface of the valve. These appearances have received the name of "vittæ" from Kützing, and "canals" from Meneghini, but either term appears to be unsuitable if their true nature is considered. Ralfs, who was cognizant of the true character of the septa, but who does not appear to have apprehended the mode of their formation, accurately describes the appearances to which they give rise (Transactions of the Botanical Society of Edinburgh, vol. ii. p. 22), as "produced by siliceous plates arising internally from the margin of the filament, and extending towards, but not reaching the centre. The interior is thus divided into chambers opening into a central space. When viewed laterally, the central space has the appearance of a canal, especially as the inner edge of each plate has a concave outline. This appearance is more striking in *Tabellaria*, *Striatella tæniæformis* (= *Grammatophora marina*, Kütz.), and *Tetracyclus lacustris*, where all the plates are nearly equal; but in *Striatella arcuata* (= *Rhabdonema arcuatum*, Kütz.) and *Tessella Catena*

(=*Rhabdonema minutum*, Kütz.), they are shortest near the angles, and gradually longer as they approach the middle. In the latter the outlines of two plates are frequently seen at one time when viewed laterally, in consequence of the unequal size of the plates" (see Plate XXXVIII. 306 *a* & *a''*, Plate XXXIX. 307 *h*),

We shall find that the septa, here so accurately described, are not invariably projected equally from all portions of the annuli, but that an annulus will project a septum from one side only, and the next annulus a septum from the side opposite its neighbour; in such cases the septa appear alternately on opposite margins of the filament, as may be seen in *Rhabdonema minutum*, *Striatella unipunctata* and *Tabellaria flocculosa*, while opposite septa, where the development takes place symmetrically around the interior of each annulus, may be noted in *Rhabdonema arcuatum* and *Grammatophora marina*. The analyses given in Plate XXXVIII. 305†, Plate XLII. 314†, Plate XLIII. 316† & 317†, will enable the student to understand the above description, and will very clearly exhibit to the eye the singular structure I have attempted to describe.

It will be seen that the annuli in the present genus are furnished towards the circumference with a single series of oblong cellules; these give a striated appearance to the F. V. of the frustule, and the number of these striæ will accurately represent the number of annuli. It is hardly necessary to say, that the peculiar structure of the frustule separates the present genus from any previously described, the form of its filament from *Tabellaria* and *Tetracyclus*, the coherence of its frustules from *Grammatophora*, and its cellulate annuli from all these and *Striatella*. I have detected conjugation and the formation of sporangia in one of our native species, viz. *R. arcuatum*. *R. minutum*, though occurring in great abundance in various localities and seasons, on the coast of Sussex, has never presented this phænomenon to my observation.

1. **Rhabdonema arcuatum**, *Kütz.* Filament slightly arcuate, substipitate; annuli from 9 to 30, 6 in ·001''; septa entire, opposite, slightly and variably unequal in length; valve linear-elliptical; striæ not extending to the extremities of valve, 16 in ·001''. Width of filament ·0011'' to ·0041''. Breadth of valve ·0006''. v.v.

Kütz. Bacill. xviii. 6. *Diatoma arcuatum*, Lyng. Tent. lxii. B. *Conferva*

striatula, Eng. Bot. 1928. *Diatoma striatulum*, Grev. B. F. p. 405. *Striatella arcuata*, Ag. Consp. p. 61. Ehr. Inf. xx. 6. Harv. Man. p. 199. Ralfs, Ann. vol. 11. pl. ix. 6. Prit. Anim. iv. 203, 204.

Marine. Hastings, Oct. 1851. Cuckmere, Sussex, April 1852. Poole Bay, Sept. 1854, *W. Sm.* Penzance, *Mr. Ralfs.* Coast of Sussex, *Mr. Jenner.* Frith of Clyde, Feb. 1854, *Dr. Arnott.*

Plate XXXVIII. 305 *f*, 305 *a*, & 305†.

2. **Rhabdonema Adriaticum,** *Kütz.* Filament arcuate, substipitate; annuli from 15 to 60, 8 in ·001″; septa perforate, alternate, gradually decreasing in length as the annuli recede from the valves; valve linear-elliptical; striæ not extending to the extremities of valve, 24 in ·001″. Width of filament ·0011″ to ·0054″. Breadth of valve ·0004″ to ·0006″. v.v.

Kütz. Bacill. xviii. 7.

Marine. Poole Bay, Nov. 1849, Sept. 1854, and Cork Harbour, Oct. 1855, *W. Sm.* Belfast Bay near Carrickfergus, July 1854, *Mr. Hennedy.* Frith of Clyde, Feb. 1854, *Dr. Arnott.* Ilfracombe, *Miss Hodgson.* (New York and Mauritius; communicated by *Dr. Arnott.* Mediterranean Sea near Marseilles, May 1854, *W. Sm.* Near Jaffa, *Mr. Johnson.*)

The above species is much less frequent than the former on the British coast, and I was unable at first to satisfy myself of its distinctness. The specimens which I collected in the Mediterranean, as well as those supplied by Dr. Arnott from New York, have enabled me to examine the form more thoroughly, and I am now satisfied that it cannot be regarded as a mere variety. The characters I have given are constant in the smallest as well as the largest filaments, and the relative length and alternate arrangement of the perforate septa are so obvious in prepared specimens, that there can be no difficulty in the determination of the species.

With the present, which occurs very sparingly in the gathering from Mauritius, there is another magnificent species with filaments occasionally reaching ·0086″ in width, and with alternate and cribrose septa; the latter give a very brilliant appearance to the aspect of the frustule. For this species I propose the name of *R. mirificum.* I have the same in a gathering from Ceylon, supplied by Dr. Kelaart.

All the species of the present genus occasionally suffer a partial displacement of their frustules, which afterwards continue to cohere by their angles; but this partial rupture is evidently due to external violence, and never occurs with that regularity which gives to *Diatoma, Tabellaria* and others the notable zigzag which characterizes their filaments.

Plate XXXVIII. 305 *b*. & 305 *a'* & *b'*.

3. **Rhabdonema minutum,** *Kütz.* Filament direct or slightly flexu-

ose; annuli 5 to 9, 12 in ·001″; septa entire, alternate, increasing in length as they recede from the valves; valve, in smaller frustules, elliptical, in larger, with a slight inflation in the centre, and produced and linear ends; striæ reaching the extremities of valve, 19 in ·001″. Breadth of filament ·0006″ to ·0029″. Breadth of valve ·0003″ to ·0005″. v.v.

Kütz. Bacill. xxi. ii. 4. *Fragilaria striatula*, Grev. B. F. p. 403. ad specim. authen. in herb. Grev. *Fragilaria Carmichaelii*, Harv. Man. p. 198. *Tessella Catena*, Ralfs, Ann. vol. 12. p. ii. 1. ad specim. authen. in herb. Jenn.

Marine. Seaford, Sussex, March 1852. Lancing, Sussex, Aug. and Nov. 1853, *W. Sm.* Swansea, *Mr. Ralfs.* Frith of Clyde, Feb. 1854, *Mr. R. Hennedy.*

Plate XXXVIII. 306.

Genus 40. **STRIATELLA**, *Ag.*

Filament compressed, stipitate; frustules imperfectly siliceous, annulate, indefinite, annuli plane; valves elliptical-lanceolate, with a median line, striated.

The stipes, which is longer in this genus than in any other of the filamentous Diatomaceæ, is a feature which cannot be overlooked; and the imperfectly siliceous nature of the frustules, the non-cellulate structure of the annuli, and the slight projection of the septa, which increase a little in length as they recede from the valves, sufficiently characterize the only species which has hitherto been detected.

The specific name is derived from the appearance of the endochrome, which in the living specimen is invariably collected in a central mass, with slender threads radiating in all directions towards the cell-wall.

The coherence of the frustules is easily disturbed, and it is not unusual to find some filaments in which an imperfect zigzag has been formed; in such cases a slight accumulation of mucus takes place at the cohering angles. The filaments are ordinarily, however, direct and continuous, and rarely consist of more than three or four, frequently of only two frustules, in which respect *Striatella* differs from *Rhabdonema* and the other allied genera, in which the filaments ordinarily contain twenty frustules or more.

The figure given by Kützing, Bacill. pl. 18. fig. v. 3, representing a smaller frustule attached to a larger, is manifestly an error arising from the accidental juxtaposition of two frustules of different filaments.

The striæ on the surface of the valve are exceedingly delicate, and require a higher power than the one we have usually employed to bring them distinctly into view.

Striatella unipunctata, *Ag.* Annuli 12 to 36, 12 in ·001″; septa alternate. Width of filament ·0022″ to ·0032″. Breadth of valve ·0006″ to ·0009″; striæ 68 in ·001″. v.v.

Ag. Consp. p. 61. Kütz. Bacill. xviii. 5. Ralfs, Ann. vol. 13. pl. xiv. 6. Harv. Man. p. 109. *Fragilaria unipunctata,* Lyng. Tent. lxii. G. Grev. B. F. p. 405. *Achnanthes unipunctata,* Grev. S. C. F. tab. 287. *Tessella Catena,* Ehr. Inf. xx. 7. Prit. Anim. iii. 180. *Tessella pedicellata,* Dujar. Inf. xx. 14.

Marine. Torbay, July 1846; Lulworth Cove, Dorsetshire, Aug. 1847; Jersey, Aug. 1852; Newhaven, Sussex, Sept. 1852; Larne and Belfast Bays, July 1853; Poole and Weymouth Bays, Sept. 1854; Cork Harbour, July and Oct. 1855, *W. Sm.* (Mediterranean Sea near Marseilles, May 1854, *W. Sm.*)

Plate XXXIX. 307: margin of a frustule, 307 *x*.

Genus 41. **TETRACYCLUS,** *Ralfs.*

Filament compressed, with a central inflation, free; frustules annulate, indefinite; annuli plane; septa alternate, equal; valves inflated at the centre, cruciform, costate.

This genus, established by Mr. Ralfs in 1843, is easily distinguished from most of its allies. *Rhabdonema minutum* and *Tabellaria flocculosa* are the only forms with which the species it includes might be confounded. It resembles *R. minutum* in the F. V. of its filament, but differs from that species in its cruciform and costate valve and equal septa, and is easily distinguished from *Tabellaria flocculosa* by its continuous filament.

The costæ in the present genus are usually pervious, and curved; occasionally, however, they are direct or interrupted.

The genus *Biblarium,* constituted by Ehrenberg in 1845, appears to differ from the present merely in the solitary character of its frustules, and this character arises from the fossil nature of the

gatherings from which Ehrenberg derived his specimens. I feel assured that all the species of *Biblarium* are filamentous in a living state, and that the greater number of them are casual varieties of *Tetracyclus lacustris*.

1. **Tetracyclus lacustris,** *Ralfs.* Extremities of valve rounded or subacute; inflations rounded, annuli 12 to 40, 6 in ·001″; septa alternate, equal in length. Width of filament ·0008″ to ·0022″. Breadth of valve at the inflation ·001″. Costæ 7 to 12, 6 in ·001″. v.v.

Ralfs, Ann. vol. 12. pl. iv. 2. 1843. Kütz. Bacill. xxix. 70. Prit. Anim. xiv. 24, 25. Raben. Süssw. Diat. pl. ix. *Biblarium Stella, B. Glans,* and *B. speciosum,* Ehr. in Kütz. Sp. Alg. p. 117, et Microgeologie, passim.

Fresh water. Dolgelly, Aug. 1843, *Mr. Ralfs.* Tonabrick Mountain, Co. Galway, July 1853, *W. Sm.* River Spey, July 1854, *Dr. Gregory.* Dolgelly Earth. (Lapland.)

Plate XXXIX. 308: margin of a frustule, 308 *x.*

2. **Tetracyclus emarginatus,** *W. Sm.* Valves constricted towards the extremities, which are rounded and subapiculate; inflations deeply notched or emarginate; otherwise like the last species.

Biblarium emarginatum, Ehr. in Kütz. Sp. Alg. p. 118, et Microgeologie, passim.

Fresh water. Mountain streams and cascades, Gap of Dunloe, Killarney, July 1855, *W. Sm.* River Spey, *Dr. Gregory.* Killiecrankie, *Dr. Greville.*

In the Killarney gathering this form occurs abundantly, and unmixed with the last; but, in the River Spey, it is sparingly present along with undoubted frustules of *Tetracyclus lacustris.* It is possibly only a variety of the latter, though its aspect is so different that the observer cannot fail to detect its presence, and to regard it as distinct. I regret that it was noticed too late to be figured in the present work.

Genus 42. **DIATOMA,** *Dec.*

Frustules oblong, adhering by their opposite, and alternate, or more rarely by their adjacent angles into a zigzag chain; valves elliptical or linear.

The position of the present genus, with its ordinary cell, in a subtribe whose genera have annulate frustules, is somewhat anomalous;

but as our Synoptical arrangement is designed to aid in the identification of species by a statement of the most obvious characters, it appeared necessary to place *Diatoma*, with its zigzag filament, near others presenting a like notable peculiarity.

No difficulty can arise in the discrimination of the species of the present genus. *Fragilaria virescens* is the only form which might possibly be assigned to *Diatoma*; but this error will be avoided by remembering that the zigzag, which is rare and accidental in *F. virescens*, is a constant and distinctive feature in all species of the present genus.

1. **Diatoma vulgare**, *Bory*. Valve elliptical, suddenly attenuate towards the obtuse extremities, costate; costæ pervious, somewhat irregular, about 18 in ·001″. Length of frustule ·0007″ to ·0021″. Breadth of V. ·0003″ to ·0005″. v.v.

β. Valve linear, extremities gradually and slightly attenuate. Length of frustule ·0018″ to ·003″. v.v.

Ralfs, Ann. vol. 11. pl. ii. 8. Kütz. Bacill. xvii. 15. Raben. Süssw. Diat. pl. ii. Hass. Alg. xciv. 1. *Bacillaria vulgaris*, Ehr. Inf. xv. 2. Var. β. *Diatoma tenue*, Ag. ad specim. authen. in herb. Grev.

Fresh water. Wareham, Dorsetshire, May 1849; Lewes, Sussex, April and Sept. 1852; Glasheen, near Cork, April 1855, *W. Sm.* Ardrossan, April 1853, *Dr. Landsborough*. Lough Leven, Oct. 1854, *Dr. Arnott*. Var. β. Plumpton, Sussex, April 1852; River Lee, near Cork, April 1855, *W. Sm.* Pentland Hills, April 1821, *Dr. Greville*. (Canal du Midi, and Canal de Crapone, South of France. β. Fountain in Hotel des Colonies, Marseilles, May 1854, *W. Sm.*)

Plate XL. 309. Var. β. Plate XL. 309 β.

2. **Diatoma grande**, n. sp. Valve linear, constricted near the rounded extremities, costate; costæ pervious, 24 in ·001″. Length of frustule ·0013″ to ·0038″. Breadth of valve ·00025″ to ·0003″. v.v.

Fresh water. River Lune, Lancashire, April 1848, *Mr. G. Smith*. River Shannon and River Corrib, July 1853; Lough Derg, July 1855, *W. Sm.* Lough Neagh, *Dr. Dickie*. Lough Leven, May 1854, *Dr. Gregory*. Allan Water, Stirling, May 1855, *Dr. Greville*. (River Sorgues, Vaucluse, May 1854, *W. Sm.*)

I was at first disposed to assign this form to *D. Ehrenbergii*, Kütz.; but as Professor Kützing describes and figures the latter with a central inflation of the valve, while the present is linear, and as authentic specimens of *D. Ehren-*

bergii, Kütz., kindly sent me by M. De Brébisson, undoubtedly belong to the next species, I have felt myself obliged to sever this beautiful form from its association with a naturalist who might otherwise worthily claim the honour of giving his name to one of the finest of the Diatomaceæ.

Plate XL. 310.

3. **Diatoma elongatum,** *Ag.* Valve linear, extremities slightly inflated, rounded, costate; costæ pervious, 18 in ·001″. Length of frustule ·0016″ to ·0042″. Breadth of valve ·00015″ to ·0002″. v.v.

β. Frustules inflated towards the extremities. Length ·0011″ to ·0025″. v.v.

γ. Frustules minute; valve elliptical. Length ·0004″ to ·0009″. v.v.

δ. Frustules distorted, irregular. Length ·0004″ to ·0011″. v.v.

Ag. Syst. p. 4. Kütz. Bacill. xvii. 18. Raben. Süssw. Diat. pl. ii. *Diatoma tenue*, Ralfs, Ann. vol. 11. pl. ix. 1. ad specim. authen. in herb. Grev. Var. β. *Diatoma Ehrenbergii*, Kütz. Bacill. xvii. 17. ad specim. quæ dedit am. De Brébisson. *Bacillaria elongata*, Ehr. Inf. xv. 5. Prit. Anim. iii. 169. *Diatoma elongatum*, Ralfs, Ann. vol. 11. pl. ix. 2. Hass. Alg. xciv. 3. Var. γ. *Diatoma tenue*, Kütz. Bacill. xvii. 9, 10. *Bacillaria flocculosa*, Ehr. Inf. xv. 9. *Bacillaria cuneata*, Ehr. Inf. xv. 6.

Fresh or brackish water. Var. α. and β. Poole Bay, March 1850; Lewes March 1852; Denton, Sussex, Nov. 1853; Cork Harbour, April 1855, *W. Sm.* Belfast, *Dr. Dickie.* Hornby, Lancashire, May 1853, *Mr. G. Smith.* Hull, Aug. 1853, *Dr. Arnott.* Tunbridge Wells and Rackham Common, Sussex, *Mr. Jenner.* Var. γ. Tarring Neville, Sussex, Nov. 1853, *W. Sm.* Ayrshire, March 1854, *Dr. Landsborough.* Var. δ. Hornby, Lancashire, May 1854, *Mr. Johnson.* Sheriffmuir, *Dr. Arnott*, October 1855. (Var. δ. Well near Marseilles, May 1854, *W. Sm.*)

This most changeable species has received from observers almost as many names as it presents diversities in size, and yet I feel persuaded, from a wide comparison of specimens, that all the forms I have indicated must be regarded as varieties of the same, dependent upon the stages of its growth, or the circumstances which attend its development.

Var. β, which has been the most confidently separated from the type, is perhaps the least constant of any in the character which has been relied upon as a distinction; frustules with the extremities inflated on a front view, or rather those in which the connecting membrane has slightly collapsed towards the centre of the frustule, being almost invariably found intermixed with others of a perfectly oblong outline, and the two not unfrequently occur together in the same filament. Even the singular variety figured in Plate XLI. 311 γ. *f'*, and which Ehrenberg has placed apart as *Bacillaria cuneata*, will be seen to be accidental, and is found in association with frustules undoubtedly belonging to the normal form.

The bizarre forms, produced by the capricious mode in which the partial separation of the frustules in the chains is effected, have also occasioned confusion; but a little study of specimens from various localities, and collected at different seasons, will satisfy the student of the impropriety of relying upon these accidental peculiarities as the bases of specific distinction.

The present may be distinguished from the last species, not only by its smaller size, but by the inflation of the extremities of the valves. In *D. grande* the apparent enlargement of the extremities is produced by a constriction; in *D. elongatum* the extremities in the mature frustules are absolutely wider than any other portion of the valve.

Plate XL. 311. and Pl. XLI. 311. Var. β. Pl. XLI. 311 β. Var. γ. Pl. XLI. 311 γ. Var. δ. Supp. Plate LX. 311 δ.

4. **Diatoma hyalinum,** *Kütz.* Filaments of numerous frustules; valve linear-elliptical, extremities somewhat acute; striæ obscure. Length of frustule ·0008″ to ·0052″. Breadth of V. about ·0003″. v.v.

Kütz. Bacill. xvii. 20, et *Diatoma vitreum,* Kütz. Bacill. v. 7, xvii. 19, xxiv. 1. ad specim. authen. quæ dedit amic. De Brébisson. *Striatella tæniæformis,* var. α, Ralfs, Trans. Bot. Society of Edinburgh, vol. ii. p. 22?

Marine. Jersey, Aug. 1852; Larne, July 1853; Newhaven, Sussex, Aug. 1853, *W. Sm.* Saltcoats, Oct. 1853, *Dr. Arnott.*

Plate XLI. 312.

5. **Diatoma minimum,** *Ralfs.* Filaments of two or three frustules; valve elliptical; extremities rounded; striæ obscure. Length of frustule ·0002″ to ·0004″. Breadth of V. about ·00015″. v.v.

Ralfs in Trans. Bot. Society of Edinburgh, vol. ii. p. 20?

Marine: parasitic upon frustules of *Surirella Gemma.* Hove, Sussex, Sept. 1853, *W. Sm.*

I cannot refer this form with certainty to Mr. Ralfs' species, not having seen specimens of the latter; the present, however, agrees with Mr. Ralfs' description, "Frustules very minute, about twice as long as broad."

Plate XLI. 313.

Genus 43. GRAMMATOPHORA, *Ehr.*

Frustules oblong, adhering by their opposite and alternate, or more rarely by their adjacent angles into a zigzag chain, annulate and septate, definite; septa opposite, usually more or less curved; valves linear or elliptical.

The curvatures of the septa, which are very conspicuous in most species, appear like lines of written characters on the F. V. of the frustule, and justify the very significant name given to the present genus.

In some species these flexures are, however, very slightly marked; in others entirely absent; so that the distinctive character of the genus must be sought for in its zigzag filament, definite frustule, and opposite septa. One or other of these features distinguish it from *Rhabdonema*, *Striatella*, and *Tetracyclus* on the one hand, and *Tabellaria* on the other; while the annulate character of the frustule separates it from any other form. Thirteen species of *Grammatophora* are described in the 'Species Algarum'; but many of these differ only in their relative size and the outline of the valve. Looking at the great diversity that may be found in *G. marina* and *G. serpentina* in these respects, I am disposed to believe that most of the above forms may be reduced to these very common species.

1. **Grammatophora marina,** *Kütz.* Septa with a single curvature near the margin of the frustule; valve elliptical or linear-lanceolate, occasionally linear, with slightly attenuate and capitate extremities, striated; striæ 44 in ·001′′. Length of frustule ·0005″ to ·0051″. Breadth of valve ·0002″ to ·0005″. v.v.

Kütz. Bacill. xvii. 24; Sp. Alg. p. 120. *Diatoma marinum*, Lyng. Tent. lxii. A. Ag. Consp. p. 53. Ralfs, Ann. vol. 11. pl. ix. 5. Grev. B. F. p. 405. Harv. Man. p. 201. *Conferva tæniæformis*, Eng. Bot. tab. 1883. Ag. Consp. p. 54. *Diatoma brachygonum*, Grev. B. F. p. 406. Harv. Man. p. 202.

Marine: very frequent. Torbay, July 1846; Poole Bay, July 1848; Coast of Sussex, Aug. 1850; Cork Harbour, June 1855, &c., *W. Sm.* (Mediterranean Sea near Marseilles, May 1854, *W. Sm.* Mauritius, *Dr. Arnott.*)

Plate XLII. 314.

2. **Grammatophora macilenta,** n. sp. Frustules often curved; septa as in the last species; valve linear, slightly inflated at centre and extremities; striæ 60 in ·001″. Length of frustule ·0011″ to ·0056″. Breadth of valve ·00015″. v.v.

Marine. Salt Pans, Hampshire, Sept. 1854; Cork Harbour, July 1855, *W. Sm.* (The Levant; communicated by *Mr. Johnson.*)

The F. V., like the valve, in this species, is always much narrower in proportion to its length than in the last; this arises from the less convexity of the valves, and from the slight development of the connecting membrane. The striæ are also far more numerous than in *G. marina*; and the frustule, especially in the larger specimens, shows a decided tendency to assume a curved form.

Supp. Plate LXI. 382.

3. **Grammatophora serpentina,** *Kütz.* Septa with two or more curvatures, and a hamulous extremity; valve linear, slightly attenuate or cuneate towards the obtuse or rounded extremities; striæ 42 in ·001″. Length of frustule ·0009″ to ·0062″. Breadth of valve ·0007″. v.v.

Kütz. Bacill. xxix. 82; Sp. Alg. p. 121. *Striatella tæniæformis* γ, Ralfs, Ann. vol. 11. pl. ix. 5. β.

Marine. Torbay, July 1846; Cork Harbour, Oct. 1855, &c., *W. Sm.* Ilfracombe, March 1852, *Mr. Ralfs.* The Clyde, Feb. 1854, *Mr. Hennedy.* (Algoa Bay; Guano from Ichaboe; Mediterranean near Marseilles, &c., *W. Sm.*)

Mr. West, while engraving the present species, called my attention to the existence of a faint median line, with occasionally distinct central and terminal nodules, in both *G. marina* and *G. serpentina*: he also remarks that the striæ in the former case are composed of markings in linear series; while those of *G. serpentina* have the striæ made up of markings disposed in quincunx, the resultant lines in the one being in consequence parallel, and in the other oblique. There can be no doubt of the general accuracy of these remarks; but I have not been able to assure myself that these features are uniform and constant, and therefore hesitate to adopt them as specific distinctions.

4. **Grammatophora? Balfouriana,** *W. Sm.* Septa direct, without curvatures, perforate; valves linear, elliptical; striæ 45 in ·001″. Length of frustule ·0005″ to ·0012″. Breadth of valve ·00015″ to ·00025″. v.s.

Diatomella Balfouriana, Grev. Ann. ser. 2. vol. 15. pl. ix. 10–13.

Fresh water. Canlochlan and Glen Callater, Perthshire, Aug. 1854,

Dr. Balfour. Aberdeenshire, *Dr. Dickie.* Pass of Killiecrankie, *Mr. P. Grant.* Ben Lawers, elev. 1700 feet, Aug. 1855, *Dr. Arnott.* Perthshire, *Dr. Greville.*

I first detected this interesting species in gatherings made by Dr. Balfour in the above localities, and subsequently found it in collections of Dr. Dickie and Mr. P. Grant, which have been in my possession for several years. Dr. Arnott and Dr. Greville have since supplied me with specimens from other localities. In every case the form is, however, very sparingly distributed amongst other *Diatomaceæ*, and in no instance have I seen it in a fresh or living state. In ignorance of its general habit and character, not even certain to which subtribe it properly belongs, I am unable to determine its generic position, and am obliged to place it with those species to which it most nearly approaches in the structure of its frustule. These certainly are the species included under the present genus, its frustules being annulate and definite, and the septa opposite. Should a further acquaintance with the species in a living state enable me to place it with confidence among those forms that unite after self-division into a zigzag chain, I know of no character that would separate it from *Grammatophora*. The absence of a curve in its septa, relied upon by Dr. Greville, I cannot regard as of sufficient importance to constitute a generic distinction, as this feature is scarcely noticeable in some states of *G. macilenta* (see Plate LXI. 382), and is uniformly absent in *G. stricta*, Ehr. (see Kütz. Bacill. xxix. 76).

If, however, future observation require the separation of the present species from the genus *Grammatophora*, I must at all events deprecate the adoption of the name *Diatomella*, as contrary to a canon of nomenclature now, I believe, generally received, viz.:—"Generic names are inadmissible that are founded upon a resemblance to other genera, and which express this resemblance by diminutives, or by syllables, either prefixed or added."—*DeCandolle*, Théorie Elém. Part III.

Supp. Plate LXI. 383.

Genus 44. **TABELLARIA**, *Ehr.*

Frustules oblong, cohering into a zigzag chain, annulate; septa alternate, entire, direct; valves linear, inflated at the centre and extremities, striated.

The annulate frustules and inflated valves distinguish the present genus from *Diatoma*, and the alternate septa from *Grammatophora*. Professor Kützing has described three recent species of this genus, finding a character for one of these in its opposite "vittæ," and distinguishing the other two by the circumstance of the one having

its valvular inflations of equal size, and the other having the central inflation larger than the terminal enlargements. I cannot accept any of these characters as a sufficient specific distinction. In all the specimens I have examined, and it will be seen how widely these have been collected, I find alternate septa. The alternate character is distinctly obvious to the eye in *T. flocculosa*; but that their position and character are precisely similar in *T. fenestrata*, must I think be apparent by an examination of the analyses given in Plate XLIII. 316† & 317†; in both, the septa are confined to one extremity of each annulus, and must therefore in both be really alternate.

With regard to the character on which Kützing relies as separating his *T. ventricosa* from *T. flocculosa*, viz. the relative sizes of the central and terminal inflations, I have only to say, that, in the numerous specimens in my possession, I find these characters exceedingly variable, and in no case have I met with valves in which the central does not in some degree exceed the terminal enlargements.

I therefore feel myself obliged to unite all these specimens under one designation, and, although the specific name of *ventricosa* may be the more appropriate one, must adhere to the term which has priority and almost universal usage in its favour.

1. **Tabellaria flocculosa**, *Kütz.* Frustules indefinite; septa from 3 to 5 from each margin, slightly unequal. Length of frustule ·0006″ to ·0016″. Valve with the central inflation the largest; striæ indistinct, about 36 in ·001″. v.v.

Kütz. Bacill. xvii. 21. Raben. Süssw. Diat. x. 2. Hass. Alg. xciv. 9. *Tabellaria ventricosa*, Kütz. Bacill. xxx. 74. Raben. Süssw. Diat. x. 5. *Conferva flocculosa*, Dillw. Conf. xxviii.? *Bacillaria tabellaris*, Ehr. Inf. xv. 7. *Diatoma flocculosum*, Lyng. Tent. lxi. B. 4? Ralfs, Ann. vol. 11. pl. ix. 3. ad specim. authen. in herb. Jenn.

Fresh water: frequent in boggy pools. Wareham, Dorsetshire, Dec. 1849; Plumpton, Sussex, May 1853; Grassmere, Westmoreland, and Rackham, Sussex, Aug. 1853; River Lee, near Cork, April 1855, *W. Sm.* Jackswood, and Coldbath Springs, Tunbridge Wells, Dec. 1842, *Mr. Jenner*. Lancashire, March 1852, *Mr. Johnson*. Aberdeenshire, *Dr. Dickie*. Ben M^{c} Dhui, elev. 3840 feet, *Mr. P. Grant*. Woodhead, Cheshire, May 1853, *Mr. T. Brittain*. Isle of Arran, July 1853, *Dr. Arnott*. Ben Lawers, Aug. 1853, *Professor Williamson*. Braemar, Aug. 1854, *Dr. Balfour*. Lough Mourne, Peterhead, and Lough Island Reavey Deposits. (Falaise, *M. De Brébisson*. Lac Guery, Mont Dore, elev. 4062 feet, June 1854, *W. Sm.*)

Plate XLIII. 316.

2. **Tabellaria fenestrata**, *Kütz.* Frustules definite; septa 2 from each margin, equal. Length of frustule ·0008″ to ·0046″; inflations of the valve nearly equal in width; striæ as in the last. v.v.

Kütz. Bacill. xvii. 22. Raben. Süssw. Diat. x. 1. *Diatoma fenestratum*, Lyng. Tent. lxi. E? Ralfs, Ann. vol. 11. pl. ix. 4. ad specim. authen. in herb. Jenn.

Fresh water: often with the last. Wareham, Dec. 1849; Studland, Dorsetshire, Sept. 1853; Maam, Galway, and Botanic Garden, Belfast, July 1853; Grassmere, Westmoreland, and Rackham, Sussex, Aug. 1853; River Lee, near Cork, April 1855, *W. Sm.* Rackham, Oct. 1842, *Mr. Jenner.* Ormesby, Norfolk, Aug. 1853, *Mr. Brightwell.* Haverfordwest, March 1854, *Mr. Okeden.* Ulverstone, Lancashire, Aug. 1854, *Miss E. Hodgson.* Lough Mourne and Lough Island Reavey Deposits. Dolgelly Earth. (Falaise, *M. De Brébisson.* Pic de Sancy, Mont Dore, elev. 6000 feet, June 1854, *W. Sm.*)

Very like the last in the S. V. of its valve, especially in small specimens, but always to be known from it by the *definite* structure of the frustule.

Plate XLIII. 317.

Genus 45. **AMPHITETRAS**, *Ehr.*

Frustules cubical, cohering into a zigzag attached filament; connecting membrane cellulate, imperfectly annulate, indefinite; valves quadrangular, cellulate; cellules circular, radiate, or irregularly concentric, inconspicuous at the angles of the valve.

The cubical outline of the frustules distinguishes the species included in the present genus from all our other native forms. The irregular development of the connecting membrane and its annulate structure ally it to the several genera lately described; but the entire absence of internal septa is a character which places *Amphitetras* apart from *Tabellaria*, and, together with the zigzag of its filaments, forbid its union with *Rhabdonema* or *Tetracyclus*. The projection of the connecting membrane beyond the suture of the valve is a circumstance which meets us for the first time in *Amphitetras*; it will also be found in *Biddulphia*; and the enlarged appearance which is thus given to the central portion of the mature frustule is a conspicuous character in these genera.

1. **Amphitetras antediluviana,** *Ehr.* Frustules cubical; margins on S. V. nearly straight, forming a square. Length of a side of valve ·0011″ to ·0042″. v.v.

β. Margin of valve deeply concave; frustule in consequence cruciform. Distance between the adjacent angles of valve ·0025″ to ·0062″. v.v.

Ralfs, Ann. vol. 12. pl. viii. 5. Kütz. Bacill. xix. 3. Prit. Anim. xiv. 21, 22. Var. β. Kütz. Bacill. xxix. 86.

Marine. Torbay, June 1846; Poole Bay, July 1849 and Sept. 1854, *W. Sm.* Haverfordwest, July 1854, *Mr. Okeden.* Ilfracombe, *Mr. Ralfs.* Torbay, *Mrs. Griffiths.* Var. β. Stomach of Crab, *Professor Williamson.* Ipswich, Aug. 1852, *Mr. Hodgson.* Cumbrae, Feb. 1854, *Mr. R. Hennedy.* (Var. β. Salt Pans near Agde, South of France, May 1854, *W. Sm.*)

It is probable that the above Var. β. has a claim to be esteemed a distinct species. I have not found well-marked specimens of the two forms in any instance intermixed, and the deeply excavated sides, and, in consequence, cruciform outline of the frustule, are as notable in the smallest as in the largest individuals of the Mediterranean gathering. I have distributed specimens of the latter under the name of *A. excavata*; but, in deference to the opinion of my esteemed correspondent Dr. Walker-Arnott, have determined to retain it for the present as a variety of the more usual form.

Plate XLIV. 318. Var. β. Plate XLIV. 318 *a*‴.

Genus 46. **BIDDULPHIA,** *Gray.*

Frustules compressed, adhering more or less perfectly into a continuous or zigzag filament; valves convex, elliptical, usually spinose and cellulate; cellules circular; angles of valves produced into rounded or horn-like processes.

The frustules of *Biddulphia* are so various in outline, that it is difficult to fix upon any constant generic characters descriptive of their form; they all, however, agree in having compressed frustules, with the angles of the valves produced, and in presenting a cellulate structure, not only in the valves, but also in the connecting membrane. The latter is frequently projected beyond the suture, and appears as an encircling band of silex standing out from the general surface of the valve. Frustules of *Eupodiscus*, adhering after self-division, often closely resemble *Biddulphia*; they differ, however, in the orbicular outline of their valves, and in the processes of the

latter being rather projections from the disk than produced angles. I have given in Plate LXII. fig. 255. front views of *Eupodiscus radiatus*, which I had not seen when the figure in Plate XXX. was drawn: the distinctive characters of the two genera, as far as regards the forms and structure of the frustule, may be easily seen on a comparison of these figures with those of *Biddulphia* given in the former plate.

The extremities of the produced angles in *Biddulphia* appear to be deficient in the distinct cellular structure of the general surface of the valve; this probably arises from the slighter impregnation of silex at these parts of the cell-membrane, which is occupied for some time after its formation in the secretion of the mucus that retains the frustules in their filamentous connexion. The small amount of silex at these parts often disappears during maceration in acid, or upon exposure to the air, and the result is that the extremities of the processes appear as if perforated. That openings do not exist at these parts during the life of the frustule, may, however, easily be proved by compressing the specimens under the microscope, when the endochrome is seen to escape at the suture, and not by the processes.

1. **Biddulphia pulchella,** *Gray.* Valve elliptical; margin undulated, undulations arising from three to seven transverse elevations, the summit of the central elevation armed with two or three abbreviated, awl-shaped spines, which in the larger specimens are sometimes slightly capitate; elevations of the valve separated by costæ; cellular structure conspicuous; processes semi-globular. Length of valve ·0025″ to ·0062″. v.v.

Gray, Nat. Arr. of Brit. Plants, vol. i. p. 294. Ralfs, Ann. vol. 12. viii. 3. Prit. Anim. xiii. 46–50. *Conferva Biddulphiana*, Eng. Bot. tab. 1763. *Diatoma Biddulphianum*, Ag. Syst. p. 5. *Biddulphia tri-locularis, quinque-locularis*, et *septem-locularis*, Kütz. Bacill. xxix. 89, xix. 1 & xix. 2.

Marine. Ilfracombe, 1838, *Mr. Ralfs.* Torquay, 1849, *Mrs. Griffiths.* Torquay, Aug. 1846; Poole Bay, Sept. 1851; Cork Harbour, Aug. 1856, *W. Sm.* Portsmouth, *Mr. C. Poulton.* Harwich, *Mr. Bleakeley.* (Cherbourg, *M. De Brébisson.*, Mediterranean Sea near Marseilles, May 1854, *W. Sm.* Mauritius, *Dr. Harvey*; communicated by *Dr. Arnott.* Ceylon, *Dr. Harvey*; communicated by *Dr. Kelaart.*)

When viewed with a low power of the microscope, as in Plate XLVI. 321 *f*, no description of this beautiful species can be more graphic than that given by Dr. Greville (Brit. Flora, vol. ii. p. 405) of the form he describes as *Dia-*

toma auritum, and which is probably identical with the present, when he says, "the auricular angles give to the frustules the appearance of microscopic wool-packs."

Plate XLIV. 321, Plate XLV. 321, and Plate XLVI. 321.

2. **Biddulphia aurita**, *Bréb.* Valve elliptical-lanceolate, with a central inflation armed at its summit with two or three awl-shaped spines; cellular structure obscure; processes horn-like, obtuse, inflated at base. Length of valve ·0005″ to ·0022″. v.v.

De Brébisson, Consid. sur les Diatomées, 1838, p. 12. Ralfs, Ann. vol. 12. viii. 4. *Diatoma auritum*, Lyng. Tent. lxii. D. *Odontella aurita*, Ag. Consp. p. 56. Eng. Bot. tab. 2842. Kütz. Bacill. xxix. 88. *Denticella aurita*, Ehr. Microg. xxxv, A. xxxiii. 7.

Marine. Eastbourne, Sussex, Feb. 1842, *Mr. Jenner*. Poole Bay, June 1849; Pevensey, Sussex, Sept. 1850, Nov. 1851, March and May 1852; Cork Harbour, July 1855, *W. Sm.* River Nene, Norfolk, May 1853, *Mr. S. Smith*. The Clyde, Feb. 1854, *Mr. Hennedy*. Saltcoats, Feb. 1854, *Dr. Arnott*. Milford Haven, March 1854, *Mr. Roper*, and May 1854, *Mr. Okeden*. Kinghorn, Fife, April 1854, *Dr. Greville*. Newbie Deposit, *Prof. Harkness*.

A widely-distributed species, but rarely occurring in much abundance. I quite agree with M. De Brébisson in associating it with the last species, and in cancelling the newer genus *Odontella*. The existence of septa in *B. pulchella* is by no means to be admitted, though the costæ may occasionally project to some extent into the interior of the cell; but the presence of such costæ is no more to be regarded as a generic character than that of similar costæ in *Isthmia nervosa*; yet to separate the latter generically on such grounds from *Isthmia enervis*, would obviously violate their natural affinities. I ought perhaps to have added to the above synonyms *Odontella subæqua*, *O. obtusa*, and *O. turgida* of Kützing and Pritchard, as I am disposed to believe that these species are merely forms of the present, and my Sussex gatherings exhibit variations in outline which closely approximate the forms there occurring to Kützing's figures; in the absence of authentic specimens, I have, however, thought it better to leave the matter open for future determination.

Plate XLV. 319.

3. **Biddulphia Rhombus**, *W. Sm.* Valve orbicular-lanceolate; spines submarginal, awl-shaped, abbreviated; cellular structure distinct; cellules in quincunx; processes horn-shaped. Length of valve ·0021″ to ·0055″. v.s.

Zygoceros Rhombus, Ehr. in Kütz. Bacill. xviii. 9. Roper, Mic. Trans. vol. 2. vi. 5.

Marine or brackish water. River Ouse near Lewes, July 1850, Sept. 1851, *W. Sm.* Breydon, Norfolk, *Mr. Bridgman.* Thames mud, *Mr. Roper.* Wisbeach, *Mr. S. Smith.* Haverfordwest, July 1852, and Carmarthen, Sept. 1854, *Mr. Okeden.*

Hitherto this species has only occurred to me in a dead state, and as isolated frustules; but its form and structure are too near those of a *Biddulphia* to permit its separation, and the filamentous condition of the species will no doubt reward future explorers of the tidal harbours and estuaries of Britain.

Plate XLV. 320. Plate LXI. 320.

4. **Biddulphia Baileyii,** *W. Sm.* Valve imperfectly siliceous, with two slight median elevations, each armed with one or two very long awl-shaped spines; processes somewhat linear towards the truncate apices; cellules in linear arrangement. Length of valve ·0025″ to ·0053″. v.s.

Zygoceros Mobilensis, Bail. Obs. 34 & 35?

Marine. Poole Bay, July 1848; Stomach of Pecten, Coast of Sussex, March 1854, *W. Sm.* Scarborough, Aug. 1854, *Prof. Williamson.*

The present, if not identical with Prof. Bailey's species, is sufficiently near to justify me in dedicating it to that excellent observer.

Plate XLV. 322. and Plate LXII. 322.

5. **Biddulphia turgida,** *W. Sm.* Valve elliptical, furnished with a submarginal circlet of short abbreviated spines, and with two long submedian awl-shaped spinous processes, together with the angular processes, which are large, linear and truncate; cellules distinct, in linear arrangement. Length of valve ·0035″ to ·0048″.

Cerataulus turgidus, Ehr. in Bail. Obs. fig. 25 & 27.

Marine. Newland near Haverfordwest, 30 feet below the surface, July 1854, *Mr. Okeden.*

This fine species, which we owe to the patient enterprise of Mr. Okeden, has not hitherto been found in Britain in a living state; it appears, however, to be so near the form figured by Prof. Bailey, that I have not hesitated to assume their identity. The mode in which the specimens were procured, by means of an apparatus especially constructed for the purpose, is described in an interesting paper by Mr. Okeden in the Journal of Microscopical Science, vol. iii. p. 26.

Plate LXII. 384.

6. **Biddulphia regina,** n. sp. Valves with three median elevations,

the central and largest unarmed; processes little exceeding the median elevation in length; papillate, rounded; cellules of elevations distinct, those of valve and connecting-membrane minute. Length of valve ·0033″ to ·0058″.

Marine. Dredged off the Island of Skye by *Mr. Barlee*; communicated by *Prof. Williamson*, Jan. 1852.

In a letter from Prof. Williamson, he says that the present beautiful species has been referred by Prof. Bailey to *Zygoceros* under the name of *Z. Tuomeyii*. I have no means at hand of determining the point, nor of ascertaining the identity of the American with the British species.

Plate XLVI. 323.

Genus 47. **ISTHMIA**, *Ag.*

Frustules compressed, trapezoidal, one valve with a produced angle, at which mucus is secreted, serving to retain the frustules after self-division in an irregularly-branched filament; valves convex, or subcylindrical; S. V. elliptical. Structure cellulate; cellules more or less hexagonal.

The mode in which the frustules cohere after self-division in the present genus is quite peculiar; their attachment not being at apposed angles, as throughout the subtribe, but indiscriminately to any part of the adjacent frustule; this gives a branch-like appearance to the aggregated filament. The cause of this irregularity is quite obscure. The little cushion of mucus, by which the frustules cohere, is evidently produced subsequent to self-division, and the angle which secretes this mucus is easily known by its more minute cellules and less firmly siliceous membrane. The two British species which the genus contains, have been so inextricably confounded together under the common name of *I. obliquata*, that it appears expedient to adopt new specific names for both; characters for which, following Kützing, I find in the costæ, so conspicuous in the one, but absent in the other. The comparative length or breadth of the frustules, relied upon by most writers, are characters wholly to be discarded, being dependent upon the stage of growth or accidental circumstances, and equally variable in both species. The synonymy, from the confusion to which I have alluded, is very uncertain; but I have endeavoured to

reduce it to some rule by assigning to *I. nervosa* all species which have been described as "striated;" though still in doubt whether the arrangement of the cellules may not in some cases, under imperfect instruments, have been regarded as "striation."

1. **Isthmia nervosa,** *Kütz.* Valves inflected towards the suture, transversely lined by costæ which anastomose and disappear towards the centre of valve; cellules of connecting-membrane much enlarged near the suture. Length of valve ·0024″ to ·0082″. v.s.

Kütz. Bacill. xix. 5. *Isthmia obliquata,* Ag. Consp. p. 55. Ehr. Inf. xvi. 5. Ralfs, Ann. vol. 12. viii. 2. Harv. Man. p. 200. *Diatoma obliquatum,* Lyng. Tent. lxii. c. 2.

Marine. Carnlough Bay, North of Ireland, *Mr. D. Moore*; communicated by *Mr. Jenner.* "Near Glenarne," 1847, *Mrs. Lyon*; communicated by *Dr. Landsborough.* Balta Sound, *Mr. Edmonstone,* communicated by *Mrs. Griffiths.*

Plate XLVII.

2. **Isthmia enervis,** *Ehr.* Valves direct, not inflected; cellules of connecting-membrane slightly enlarged at the suture. Length of valve ·0024″ to ·0082″. v.v.

Ehr. Inf. xvi. 6. Ralfs, Ann. vol. 12. viii. 1. Kütz. Bacill. xix. 4. Prit. Anim. iv. 183. *Isthmia obliquata, β. tenuior,* Ag. Consp. p. 55. *Conferva obliquata,* Eng. Bot. tab. 1869.

Marine. Torbay, July 1846; Cork Harbour, Aug. 1855, *W. Sm.* Torbay, *Mrs. Griffiths.* Ilfracombe, *Mr. Ralfs.* Maiden Rocks, near Larne, *Dr. Dickie.* Haverfordwest, July 1854, *Mr. Okeden.*

Plate XLVIII.

Genus 48. **PODOSIRA,** *Ehr.*

Filament cylindrical, of few frustules, attached; frustules spherical or cylindrical, geminate by the persistence of the connecting-membrane as a siliceous cingulum; valves hemispherical, minutely punctate or cellulate; silex absent from the apex of the valve.

Having employed the word "*annulus*" in another connexion, I adopt the term "*cingulum*" in the present and following genus to denote the subpersistent condition of the connecting-membrane,

present in all the *Melosireæ*, but eminently conspicuous in *Podosira* and *Melosira*, retaining the frustules in these genera, after self-division, in a geminate union until the self-dividing process is renewed.

The brevity of the filaments, which rarely include more than from two to six frustules, the absence of silex at the apex of the valves, and its parasitic growth, are characteristics which place the genus *Podosira* apart from its allies. This deficiency of silex is probably to allow a free secretion of the mucus which unites the frustules, and provides a pedicel for their attachment to the plant on which they grow, as it does not occur in the non-attached valve of the first-formed frustule. In the living state, the absence of the silex is not perceived; but when the frustules have been macerated in acid, these portions of the valves appear as perforations, owing to the disappearance of the cell-membrane. A similar secretion of mucus takes place in *Melosira nummuloides β.* (Plate XLIX. 329 β.); but in this case no deficiency of silex is apparent, and no perforations are seen in any condition of the valves: the cause of this diversity of structure, under circumstances so similar, I cannot explain.

1. **Podosira Montagnei**, *Kütz.* Filaments usually of two frustules, which are at first compressed at the equator; cingulum firmly siliceous, with annulate striæ. Breadth of filament ·0018″ to ·0028″. v.v.

Kütz. Bacill. xxix. 85. *Melosira globifera*, Harv. Man. p. 196? Ralfs, Ann. vol. 12. ix. 3. ad specim. authen. in herb. Jenn. *Rosaria globifera*, Carm. apud Grev. B. F. p. 372?

Marine. Hastings, *Mr. Jenner*. Torbay, July 1846; Poole Bay, Nov. 1849 and Sept. 1851; *W. Sm.* (Near Jaffa, Levant; communicated by *Mr. Johnson*.)

Plate XLIX. 326.

2. **Podosira hormoides**, *Kütz.* Filaments of from two to six frustules, which are at first compressed at the poles; cingulum obscurely punctate. Breadth of filament ·0007″ to ·0009″. v.v.

Kütz. Bacill. xxviii. 5. & xxix. 84. Prit. Anim. xiii. 45.

Marine. Pevensey Bay, Sussex, Aug. 1850; Poole Bay, Sept. 1852; Stomach of Pecten, Coast of Sussex, Mar. 1853, &c., *W. Sm.* Frith of Clyde, Feb. 1854, *Mr. Hennedy*.

Plate XLIX. 327.

3. **Podosira? maculata,** *W. Sm.* Dry valve purplish, with alternate bands of shading, distinctly punctate.

Marine: not unfrequent in deep water. Stomach of Pecten, very abundant, Coast of Sussex, March 1853; Stomach of Pecten, Kinsale Bay, April 1855, &c., *W. Sm.* Wisbeach, Dec. 1853, *Mr. S. Smith.* Frith of Clyde, Feb. 1854, *Mr. Hennedy.* Pembroke Harbour and Thames, *Mr. Roper.* Newbie Deposit, *Prof. Harkness.* (Cherbourg, *M. De Brébisson.*)

Having never been able to detect this species in a fresh state, I cannot refer it with confidence to the present genus; its loose valves are, however, so similar to those of *P. Montagnei,* that I have felt constrained, in the absence of fuller evidence, to place it near that species. *Cyclotella Scotica,* Kütz. Bacill. plate i. fig. 2 & 3, is also exceedingly similar, and may prove to be the present species.

Plate XLIX. 328.

Genus 49. **MELOSIRA,** *Ag.*

Filament cylindrical, of numerous frustules, attached or free; frustules spherical or cylindrical, often geminate; valves hemispherical or subcylindrical, more or less convex at the junction-surfaces.

In an admirable paper on the conjugation of the Diatomaceæ, inserted in the 'Annals of Natural History' for March 1848, Mr. Thwaites suggests the propriety of separating from the genus *Melosira* all those species "whose frustules are not convex at their extremities, and which form by their close contact an uninterrupted cylindrical filament." To the genus thus formed he gave the name of *Orthosira*: this suggestion I have adopted in the present work.

Mr. Thwaites also proposes to construct a genus, "*Aulacosira,*" for the reception of such species "as are characterized by the absence in the frustule of an evident central line (suture) indicating the place of future fissiparous division, but each frustule having two somewhat distinct sulci or fossulæ passing round it." This genus I cannot adopt, as I believe the characters have no real existence, and owe their apparent presence in the species Mr. Thwaites adopted as his type, viz. *Melosira crenulata,* Kütz., only to accident, or observation under imperfect illumination. A careful study of the specimens from Aberdeen, upon which Mr. Thwaites himself founded his remarks, and gatherings from various other localities, has failed to satisfy me

that any essential differences exist between this species and other *Orthosiræ*. The "crenulations," noticed by Kützing and Thwaites, are probably owing to a slight inflection at the suture (in younger specimens) of the margins of the valves: even this inflection is, I fear, only apparent, and dependent mainly upon the adjustment of the light, as Mr. West gives little indications of it in his drawings, which are executed with scrupulous fidelity.

Adopting the genus *Orthosira*, I am therefore constrained to reject that of *Aulacosira*, and divide the species formerly included under the common name of *Melosira* into two genera; the first, *Melosira*, known by the more or less rounded outline of the valves, and the geminate union in its frustules; and the other, *Orthosira*, by having the junction-surfaces of adjacent valves plane, or truncated, the line of junction usually marked by circlets of denticulations or spines, and the frustules continuously united.

It is probable that differences exist in the formation of the sporangia of the two genera; as these bodies, very frequent in *Melosira*, are of rare occurrence in the other genus, and present peculiarities in the single native species in which they occur, which would seem to indicate specialties in the function concerned in their production. These peculiarities will be noticed elsewhere, and are not, I fear, in the present state of our knowledge, available as the groundwork of a correct classification.

1. **Melosira nummuloides,** *Kütz.* Ordinary frustules globular; sporangial frustules spherical, with the polar diameter shorter than the equatorial, all geminate; valves hemispherical, furnished with a subcentral keel or flange of silex. Breadth of ordinary filament ·0005″ to ·0008″. Breadth of sporangial filament ·0011″ to ·0013″. v.v.

Var. β. Mucus-cushion much developed.

Var. γ. Keel often obscure, or absent.

Kütz. Bacill. iii. 3. ad specim. quæ dedit cl. De Brébisson. Grev. B. F. p. 401. Ralfs, Ann. vol. 12. pl. ix. 1. *Gallionella nummuloides*, Ehr. Inf. x. 3. & xi. 1. Prit. Anim. xiv. 14. *Fragilaria nummuloides*, Lyng. Tent. lxiii. c. *Conferva nummuloides*, Dillw. Conf. p. 43. tab. B. *Melosira moniliformis*, Ag. Syst. p. 8. ad spec. authen. in herb. Grev. *Melosira salina*, Kütz. Bacill. iii. 4. sic cl. Auctor in lit. Jul. 1851. Var. β. *Melosira salina*, β. *concatenata*, Kütz. Bacill. iii. 5. & xxi. 5 *b*.

Marine, or brackish water: frequent. Poole Bay, June 1848; Seaford, Sussex, May 1850; Bexhill, Sussex, Oct. 1852; Belfast Bay, July 1853; Cork Harbour, April 1855, &c., *W. Sm.* Kinghorn, Fife, Nov. 1853, *Dr. Greville.* Newbie Deposit, *Prof. Harkness.* Var. β. Itford, Sussex, March 1853; Newhaven, Sussex, Nov. 1853. Var. γ. Seaford, Sussex, April 1854, *W. Sm.*

The synonymy of this genus is much confused, and without authentic specimens, it is impossible to determine species from the description or figures of authors. I believe that all the above forms are to be referred to a single species, which is pretty constant in every locality in which it has occurred to me. The only differences I have noticed, consist in the greater or less development of the connecting mucus-cushion, and the presence or absence of the curious keel-like rim of silex:—forms aberrant in these respects are, however, so frequently intermixed with the ordinary frustules, that I cannot regard such peculiarities as of specific importance.

All filamentous species of Diatomaceæ being probably stipitate on their first production, the free or attached condition of the *Melosireæ* cannot be regarded as even constituting varieties, and the *M. salina* β. of Kützing must therefore be discarded.

Plate XLIX. 329.

2. **Melosira Borrerii,** *Grev.* Ordinary and sporangial frustules subcylindrical, all geminate; polar usually much shorter than the equatorial diameter; valves subhemispherical, distinctly cellulate; cingulum marked with conspicuous circles of cellules. Breadth of ordinary filament ·0011″ to ·0022″. Breadth of sporangial filament ·0031″ to ·0052″. v.v.

Var. β. Filaments very much curled.

Grev. B. F. p. 401. Ralfs, Ann. vol. 12. pl. ix. 2. ad specim. authen. in herb. Jenn. Thw. Ann. 2nd ser. vol. i. pl. xi. C. *Gallionella lineata,* Ehr. Inf. x. 2 C? *Melosira moniliformis,* Kütz. Bacill. iii. 2. ad specim. quæ dedit cl. De Brébisson. *Melosira nummuloides,* Ag. Consp. p. 65. ad specim. authen. in Herb. Grev.

Marine, or brackish water. Poole Bay, in great abundance, Nov. 1848 and March 1852; Coast of Sussex, Dec. 1851 and Feb. 1852, *W. Sm.* Aberdeen, June 1848, *Dr. Dickie.* Belfast Bay, Sept. 1853, and Frith of Clyde, July 1854, *Dr. Arnott.* Var. β. Near Lewes, Feb. 1852, *W. Sm.*

This species is readily distinguished from the last by its larger size, and the globular and more cylindrical form of its frustules. Its cellulate structure, which gives a rich brown hue to the desiccated filament, also affords an easy means of identification. It would appear, from a note in the 'Conspectus,' that Agardh regarded this species as identical with his *Melosira nummuloides*; for he says,—"Specimina ex Shoreham Harbour mihi a Borrero communicata omnino conveniunt cum speciminibus, quæ ipse cum Hoffmanno legi;"

and yet he gives as synonyms *Conferva nummuloides*, Eng. Bot. tab. 2287, and *Fragilaria nummuloides*, Lyng. Tent. tab. 63, both of which species are referred by most authors to our first species, and the figures of which are certainly more accordant with that than with our *M. Borrerii*. The words in the Conspectus, "articulis circularibus," are also inapplicable to the specimens from Shoreham, and are correctly descriptive of our *M. nummuloides*. It is probable, therefore, that Agardh was unable with his instrument to discriminate between these forms, and assigned them in different states to different species. In uncertainty, I adopt the name of *M. Borrerii*, under which, in honour of an excellent native observer, the species was first described in Britain, and whose discovery of it in Shoreham Harbour appears to have been almost simultaneous with the determination of Agardh's *M. nummuloides*, and venture to hope that the description and figures now given will prevent future misunderstanding. The sporangia of *M. Borrerii* are of great size, and when in this state its filaments run no risk of being confounded with any of its allies.

Plate L. 330.

3. **Melosira subflexilis,** *Kütz.* Frustules at first cylindrical, frequently united by a mucus-cushion, geminate; mature and sporangial frustules subglobular; young valves cylindrical, with a slight constriction between the apex and suture; mature valves subhemispherical; extremities of valves always convex. Breadth of filament ·0002″ to ·0008″. Breadth of sporangial filament ·0011″. v.v.

Kütz. Bacill. ii. 13. Raben. Süssw. Diat. ii. *Conferva lineata*, Dillw. Conf. tab. B. Lyng. Tent. lxiii. B.

Fresh or brackish water. Wareham, Dorset, Nov. 1849; Lewes, Sussex, December 1851, March 1852; Denton, Sussex, November 1853, *W. Sm.* Carrickfergus, September 1853; Largs, July 1854, *Dr. Arnott.* Aberdeenshire, June 1848, *Dr. Dickie.*

Plate LI. 331.

4. **Melosira varians,** *Ag.* Ordinary frustules cylindrical; sporangial at first globular, at length cylindrical; valves cylindrical, with truncated extremities. Breadth of filament ·0002″ to ·0011″. Breadth of sporangial filament ·0015″. v.v.

Ag. Consp. p. 64. ad specim. authen. in Herb. Grev. Ralfs, Ann. vol. 12. pl. ix. 5. ad specim. in Herb. Jenn. Kütz. Bacill. ii. 10. ad specim. quæ misit am. De Brébisson. Hass. Alg. xciii. 4 & 5. Thw. Ann. 2nd ser. vol. 1. pl. xi. A. Prit. Anim. xxiv. 32. *Gallionella varians*, Ehr. Inf. x. 4. *Conferva fasciata*, Dillw. Conf. tab. B.

Fresh water: very frequent. Winterbourne, Lewes, April 1852. Itford,

Sussex, September 1853. Landport, Sussex, December 1853, &c., *W. Sm.* Aberdeenshire, November 1851, *Dr. Dickie.* (Vaucluse, Le Puy, Puy de Dôme, Source of the Loiret near Orleans, and Champs Elysées, Paris, 1854, *W. Sm.*)

The only species with which this universally distributed form can be confounded is the last; but from this a careful examination will enable the observer to separate it. *M. varians* has the extremities of its frustules closely applied and partially truncate; those of *M. subflexilis* are often more or less separated by a mucous cushion, and distinctly convex. The latter species has never occurred to me except in water under marine influences. *M. varians* is found in every clear spring and river, from the lowest to the most elevated situations. *M. subflexilis*, when found in abundance, appears as a dark green iridescent mass. *M. varians* always presents a rich golden-yellow or chestnut hue to the eye. The geminate arrangement of the frustules is conspicuous in *M. subflexilis*, and indistinct in *M. varians*. The two species have been often confounded, but I think the differences they present are quite sufficient to warrant their separation.

Plate LI. 332.

5. **Melosira nivalis,** n. sp. Frustules subcylindrical; valves subhemispherical, distinctly cellulate; cellules circular; extremities of valves more or less truncate. Breadth of filament ·0002″ to ·0007″. v.v.

Fresh water: alpine pools. Snow mud, Ben Mᶜ Dhui, elev. 2800 feet, *Dr. Dickie.* Pass of Killiecrankie, August 1854, *Dr. Greville.* Mull Deposit, *Dr. Gregory.* (Pic de Sancy, elev. 6000 feet, June 1854, *W. Sm.*)

The present species hardly differs from the next except in the greater distinctness of the cellules, a character probably insufficient to justify their separation.

Plate LIII. 336.

6. **Melosira distans,** *Kütz.* Frustules subglobular; valves subhemispherical, obscurely cellulate. Breadth of filament ·0002″ to ·0009″. v.v.

Kütz. Bacill. ii. 12. *Gallionella distans,* Ehr. Microg. tab. xv. F. ad specimina authentica.

Fresh water. Elgin, August 1854, *Dr. Gregory.* Braemar, August 1854, *Dr. Balfour.* (Puy du Capuchin, Mont Dore, elev. 4567 feet, June 1854, *W. Sm.*)

Plate LXI. 385.

7. **Melosira Westii,** n. sp. Frustules subglobular; valves conical, with truncated apices, and a sutural and median siliceous ring. Breadth of filament ·0008″ to ·0016″. v.s.

Marine. Stomach of Pecten, Coast of Sussex, *W. Sm.*; detected by *Mr. West*, March 1852.

Plate LII. 333.

Genus 50. ORTHOSIRA, *Thwaites.*

Filament cylindrical, of numerous frustules, continuous, attached or free; frustules and valves cylindrical; junction-surfaces plane, line of junction usually spinous or denticulate.

1. **Orthosira arenaria,** *W. Sm.* Filament curved; cell-cavity subspherical; valves with a subsutural line of puncta; line of junction with numerous minute denticulations or spines; junction-surfaces marked with radiating striæ. Breadth of filament ·0026″ to ·0051″. v.v.

Melosira arenaria, Moore in Ralfs, Ann. vol. 12. pl. ix. 4. Kütz. Bacill. xxi. 27. Raben. Süssw. Diat. ii. 5. *Melosira arenosa*, Hass. Alg. xciii. 2 & 3. *Gallionella varians*, Ehr. Inf. xxi. 2. *G. varians, undulata*, et *biseriata*, Ehr. Microgeologie.

Fresh water. Wareham, Dorset, June 1848, *W. Sm.* Westerham, Kent, Dec. 1843, *Mr. Jenner.* Near Belfast, *Dr. Dickie.* Surrey, *Mr. Capron.* Berwickshire, *Dr. Arnott.* Queen's Park, Edinburgh, April 1854, *Dr. Greville.* Lough Mourne and Peterhead Deposits, &c. (Falaise, *M. De Brébisson.* Source of the Loiret, near Orleans, June 1854, *W. Sm.*)

In this and the two succeeding species, the cell-cavity of each frustule is more or less spherical, while the siliceous epiderm is cylindrical; hence the margins of the filaments are direct and continuous, and no depressions are conspicuous at the points where the frustules are united.

The filaments of *O. arenaria*, when dry, are of a purple colour, and exhibit a rich metallic lustre. They run no risk of being confounded with those of any other form; and it is difficult to account for the confusion into which Ehrenberg has fallen with regard to the present species, to which he seems to apply indiscriminately the names of *Gallionella varians*, *G. biseriata* and *G. undulata*.

Plate LII. 334.

2. **Orthosira marina,** *W. Sm.* Filaments direct; cell-cavity sub-

spherical; valve with large irregular cellules; and a deep submedian sulcus or depression; junction-surfaces striated; striæ radiating. Breadth of filament ·0006″ to ·0018″. v.v.

Melosira sulcata, Kütz. Bacill. ii. 7? *Gallionella sulcata*, Ehr. Microg. passim?

Marine: very generally distributed in deep water. Coast of Sussex; Cork and Kinsale Harbours, &c., *W. Sm.* Coast of Norfolk, *Mr. Brightwell.* Frith of Clyde, *Mr. Hennedy.* Pembroke Harbour and River Thames, *Mr. Capron.* River Tyne, *Mr. D. Oliver.* (Cherbourg, *M. De Brébisson.* Mediterranean, *W. Sm.* Mauritius, *Dr. Arnott.* Ceylon, *Dr. Kelaart.*)

Plate LIII. 338.

3. **Orthosira Dickieii**, *Thw.* Filaments direct; cell-cavity globular or subspherical; valves with a subsutural circlet of puncta; junction-surfaces obscurely punctate. Breadth of filament ·0005″ to ·0008″. v.v.

Thw. Ann. 2nd ser. vol. 1. pl. xii. E. Prit. Anim. xxiv. 29.

Fresh water. Cave near Aberdeen, Dec. 1847 and Nov. 1851, *Dr. Dickie.* In the same locality, Aug. 1853, *Dr. Redfern.*

The very singular process which takes place in this species, and which Mr. West has accurately figured in its various stages of development in Plate LII., is regarded by Mr. Thwaites as the formation of the sporangial frustule, and has been lucidly described by him in the volume above quoted.

It is possible that this is the correct signification of these appearances, but unhappily in no other species of this genus has there been found any analogous process; and this mode of development, in the formation of sporangia, stands alone and unsupported: this is a serious difficulty in the way of admitting Mr. Thwaites's conclusions. Another arises from the mode in which self-division takes place in the "sporangium," subsequent to its formation. It will be seen that, after the formation of a number of concentric rings of silex, the sporangia assume an elongated fusiform shape, and upon the cessation of this ring-development, an ordinary frustule makes its appearance, occupying the central portion of this fusiform body, but leaving the attenuated extremities unemployed.

This appears to be a course quite at variance with the usual mode of sporangial growth throughout the class, and throws doubt over the whole interpretation given to these phænomena.

I am therefore disposed to refer the process to that mode of abnormal development I have noted as occurring in *Meridion circulare*, *M. constrictum*, *Himantidium Soleirolii*, *Odontidium anomalum*, and *Achnanthes subsessilis*. I would particularly refer to the last, in Plate XXXVIII. 302*, as presenting phænomena closely analogous to the present, and to the expla-

nation given of it in page 7. I do not, however, put this forward as an altogether satisfactory explanation of this curious process, nor do I feel able to account for the frequency of its appearance in genera and species so widely different as *Himantidium Soleirolii* and *Orthosira Dickieii*; I only desire to record my impression that the process is not connected with the formation of sporangia, and to commend it to the study of future observers.

Plate LII. 335.

4. **Orthosira orichalcea,** *W. Sm.* Filaments direct; valves punctate; line of junction with more or less distinct subdistant denticulations; junction-surfaces smooth. Breadth of filament ·00025″ to ·0012″. v.v.

Melosira orichalcea, Melosira Italica, et *Melosira Italica var. β. crenulata,* Kütz. Bacill. ii. 14, ii. 6, et ii. 8, ad specim. quæ dedit am. De Brébisson. *M. orichalcea,* Ralfs, Ann. vol. 12. pl. ix. 6. Hass. Alg. xciii. 6, 7. ad specimina authen. in Herb. Jenn. *Aulacosira crenulata,* Thw. Ann. 2nd ser. vol. 1. pl. xi. B. ad specim. authen. quæ dedit cl. Auctor Mar. 1847. Prit. Anim. xxiv. 33. *Gallionella orichalcea,* Ehr. Inf. x. 6.

Fresh water. Cheshunt, *Mr. Hassall.* Aberdeenshire, June 1848, *Dr. Dickie.* Saltcoats, June 1854, *Dr. Arnott.* Well at Seven Churches, Clonmacnoise, July 1855. Moanarone, Co. Cork, October 1855, *W. Sm.* Premnay and Cantyre Peat; Lough Mourne Deposit and Dolgelly Earth. (Falaise, *M. De Brébisson.* Mont Dore, elev. 4500 feet, June 1854, *W. Sm.*)

In different stages of growth this species presents much diversity in the length and breadth of its frustules, and the greater or less distinctness of its denticulations; hence has arisen much confusion in the synonymy; but a careful comparison of specimens leads me to place together all the above forms. To the same species might probably be referred a large number of the forms given in the 'Microgeologie;' the absence of descriptions in the latter work, however, precludes me from attempting to give synonyms from it except in those cases when the figures are sufficiently characteristic as to preclude mistake. Sporangia are not frequent in this species; but I have found a few in the gathering from the Co. Cork.

Mr. Thwaites, whose figures I have copied in Supp. Plate E. 327, has described the sporangia as being formed at a distance from the parent valves, and "with their axes of elongation (longest diameter) at right angles to the frustule from which they originate." The peculiarity thus noticed would, if established by observation in other species, constitute a good generic distinction: I regret to say that my experience does not enable me fully to confirm the facts mentioned by Mr. Thwaites, and that I am therefore precluded from adopting them as indications of generic differences.

Plate LIII. 337.

5. **Orthosira spinosa,** n. sp. Filaments curved, often zigzag, from

the partial cohesion of their junction-surfaces; valves truncate, marked with moniliform striæ; line of junction distinctly spinous; junction-surfaces with radiating moniliform striæ and three conspicuous subcentral puncta; sporangial frustules globular. Breadth of filament ·0005″ to ·0014″. Breadth of sporangial frustule ·0019″. v.v.

Grev. in Ann. ser. 2. vol. 15. pl. iv. 14–17. *Melosira Roseana*, Raben. Süssw. Diat. x. Supp. 5 ?

Fresh water. Forfarshire Mountains, 1847, *Dr. Dickie*. Cave near Aberdeen, mixed with *Orthosira Dickieii*,. August 1853, *Dr. Redfern*. Braemar, August 1854, *Dr. Balfour*. (Cave at Royat, Mont Dore, and Cave under the Grand Cascade, Mont Dore les Bains, June 1854, *W. Sm.*)

The spinous processes in this species, though very distinct in the dry frustule, are apt to fall away or disappear when the valves are immersed in balsam; owing to this circumstance, Dr. Greville, in the paper quoted above, was at first led to doubt their presence; but having supplied him with other specimens in a dried state, my acute and accurate friend immediately replied,—"In the material of *Orthosira spinosa* you have sent me, I see an undoubted fringe of spines."

Specimens immersed in balsam also appear under the microscope of a much rounder form towards the extremities of the frustules than those in a living or dried state, and might lead the observer to place this species with *Melosira*; but the straight uninterrupted margin of the filament, the truncated valves and spinous processes, all conspicuous in the mature condition of the plant, show the propriety of placing it near the last species, and in the genus under which I have ranked it.

Plate LXI. 386.

6. **Orthosira punctata,** n. sp. Filaments direct, or slightly curved; valves conspicuously cellulate or punctate, with distinct subdistant denticulations along the line of junction. Breadth of filament ·0003″ to ·0007″. v.v.

Fresh water. Ormesby, Norfolk, October and November 1853, *Mr. Bridgman*.

A very interesting and beautiful addition to our list of British Diatomaceæ. Whether *Gallionella lineata*, *marchica*, *decussata*, *procera*, *granulata*, and *tenerrima* of the 'Microgeologie,' are any or all to be referred to *Orthosira punctata*, I must leave to be determined by those who possess authentic specimens: the figures in Ehrenberg's great work would lead me to conclude that all these forms are but varieties of the present species.

Plate LIII. 339.

7. **Orthosira? mirabilis,** n. sp. Filaments direct; valves transversely marked by curved costæ (?), which occasionally anastomose at the apices of the curves; line of junction distinctly spinous; spines very short, subdistant. Breadth of filament ·0011″. v.s.

Fresh water. Near Haverfordwest, South Wales, April 1855, *Mr. Okeden.*

This remarkable form has occurred only to the discoverer, and in small quantities. It unfortunately reached me too recently to be figured in the present work, and in a state which does not enable me to describe it as fully or satisfactorily as its singular character deserves.

Genus 51. **MASTOGLOIA,** *Thwaites.*

Frustules oblong, annulate, definite, aggregated or solitary; the mucus, secreted during self-division, more or less persistent as a mamillate cushion or frond; valves naviculoid; annuli loculated; loculi opening by foramina along the line of suture.

This genus introduces us to the second tribe of the Diatomaceæ, in which the frustules are invested with a gelatinous or membranous envelope, and, by their aggregation, form a more or less conspicuous frond. The frustules of *Mastogloia* are notably distinct from those of any of the other genera of the tribe, having the annulate structure described under the genus *Rhabdonema,* with the conspicuous canaliculi of a *Surirella.* In the present case, the canaliculi, which take the form of loculi, are, however, formed differently from those of *Surirella,* not being connected with the valve, but with the annulus, which projects as a septum into the body of the frustule. This structure will be best understood from a careful examination of the details, given in Plate LIV. fig. 341. The S. V. of the desiccated frustule, as seen with direct light, is given at *a*; the same under oblique light, and focused for the surface only, at *a′*: fig. 341 × 100 gives the valves *in situ*; and fig. 341† shows the annulus with its loculi at *h* & *h.* The size and capacity of the loculi are often conspicuous in balsam mountings, the difficulty of expelling the contained air and filling the chambers with balsam giving the appearance of empty spaces, as seen at 340 *a′*. Normally, the annular septum extends only partially across the interior of the frustule, but occasionally the loculi are seen to reach nearly as far as the median

line of the valve, as given at 341 β; this accidental modification is, however, hardly entitled to rank as a variety. The fronds in *Mastogloia* are rather the aggregated mamillæ of consolidated mucus formed around each frustule, than envelopes common to many, and their greater or less dimensions greatly depend upon the stage of growth and locality. On moist rocks, the aggregated frustules form a gelatinous and tenacious stratum, while, on water plants, each frustule adheres independently to the Alga on which it grows. The frustule itself is ordinarily eccentric to the mucus developed around it, and sits as it were on the summit of a little nipple-like cushion of gelatine: see fig. 341 × 100.

1. **Mastogloia Danseii**, *Thw.* Valve elliptical; loculi 8 to 20; striæ 42 in ·001″. Length of frustule ·0015″ to ·0020″. Breadth of valve ·0005″. v.v.

Mastogloia Danseii, Thwaites in literis, Oct. 14, 1848. *Dickieia Danseii*, Thw. in Ann. Mar. 1848, 2nd ser. vol. 1. pl. xii. K. Prit. Anim. xxiv. 30.

Brackish water. Banks of the Tamar, Devonshire, Mar. 1848, *Mr. Dansey*. "Little Sea," Dorsetshire, Oct. 1848; River Ouse, Sussex, Oct. 1852, *W. Sm.* Near Belfast, Oct. 1850, *Dr. Dickie*. Breydon, Norfolk, Sept. 1854, *Mr. Wigham*. Cumbrae Island, Oct. 1854, *Mr. Hennedy*.

This species was first determined by Mr. Thwaites in the spring of 1848, and assigned by him to the genus *Dickieia* of Ralfs; he soon, however, saw reason to doubt the accuracy of placing it in that genus, and upon my supplying him with two additional species, constituted the genus *Mastogloia* for their reception. This course was taken in consequence of the character of the frond in the present genus presenting a mamillate, and not a uniform surface as in *Dickieia*: had Mr. Thwaites been acquainted with the peculiar structure of the frustule in *Mastogloia*, he would have seen an additional and stronger reason for placing it apart.

Supp. Plate LXII. 388.

2. **Mastogloia lanceolata**, *Thw.* Valve lanceolate, elliptical, extremities acute; loculi 8 to 30; striæ 42 in ·001″. Length of frustule ·0011″ to ·0026″. Breadth of valve ·0006″ to ·0008″. v.v.

Thw. in lit., Oct. 1848. *Navicula Meleagris*, Kütz. Bacill. xxx. 37?

Brackish water. "Little Sea," Dorsetshire, Sept. 1848; Poole Bay, Sept. 1851; Lancing, Sussex, July 1854, *W. Sm.* Isle of Arran, Aug., and Isle of Cumbrae, Oct. 1854, *Dr. Arnott*. Newbie Deposit, *Prof. Harkness*.

Hardly distinct from the last, with which it often occurs intermingled: the greater number of loculi is perhaps its only important character.

Plate LIV. 340.

3. **Mastogloia Smithii,** *Thw.* Valve elliptical, extremities produced; loculi 6 to 24; striæ 42 in ·001″. Breadth of valve ·0003″ to ·0008″. v.v.

β. Extremities produced and inflated.

Mastogloia Smithii, Thw. in lit. Oct. 1848. *Navicula biscalaris,* Bréb. in lit. Jan. 1853. *Frustulia elliptica,* Ag. ad spec. in herb. Grev.?

Fresh or brackish water. "Little Sea," Dorsetshire, Oct. 1848, May 1849 and Sept. 1851; Lewes, Oct. 1851; Ballycottin Marsh, Co. Cork, May 1855; Lough Derg, Co. Clare, July 1855, *W. Sm.* Cumbrae, Sept. 1854, *Mr. Hennedy.* Lough Leven, Aug. 1855, *Dr. Gregory.* New North River, Dublin, 1852, *Mr. Shadbolt.* Lough Skaill, Orkney, Aug. 1855, *Rev. J. Pollexfen.*

Its freshwater habitat, distinctly produced and occasionally capitate extremities and variable breadth, distinguish the present species; but as it sometimes intrudes upon the localities of the species previously described, it may be readily confounded with them. I refer doubtfully to Agardh's gathering, as it was manifestly impure, containing abundance of the present species, but also, mixed with it and many freshwater forms, several species exclusively marine. The medley was such as does not naturally occur even in a brackish water locality, and contained so many forms, that the one intended by the inscription could not be satisfactorily ascertained.

Plate LIV. 341.

4. **Mastogloia apiculata,** n. sp. Valve lanceolate-elliptical, extremities slightly produced, and obtuse; loculi 30 to 50; striæ 42 in ·001″. Length of frustule ·0016″ to ·0032″. Breadth about ·0008″. v.v.

Marine. Salt Pans, Hampshire, July 1854, *W. Sm.* Donaghadee, Aug. 1854, *Mr. Hennedy.*

A very distinct species, to which perhaps *Ceratoneis laminaris* of Kützing ought to be referred; but the figures in the 'Bacillarien,' xxx. 37, are not sufficient to enable me to decide this point.

Supp. Plate LXII. 387.

5. **Mastogloia Grevillii,** n. sp. Valve linear, cuneate towards the obtuse extremities; loculi 15 to 20; striæ moniliform, 24 in ·001″. Length of frustule ·0013″ to ·0022″. Breadth of valve ·0004″. v.s.

Greg. Mic. Journ. vol. iv. pl. i. 16.

Fresh water. Pentland Hills, *Dr. Greville.* Near Silverdale, Lancashire, Dec. 1855, *Mr. Johnson.*

This interesting form was first collected by Dr. Greville in the above locality, and is well distinguished from all the other species of this genus by its coarser moniliform striæ and cuneate ends.

Supp. Plate LXII. 389.

Genus 52. **DICKIEIA,** *Ralfs.*

Frond membranous, leaf-like; frustules imperfectly siliceous, scattered, naviculoid, oblong; valves elliptical, striated.

This genus is easily distinguished from the last, from which it differs in the character of its frond, as well as the structure of its frustules. Nor is it likely to be confounded with any subsequent genus, its flat leaf-like form, and the irregular and scattered arrangement of the imbedded frustules being peculiar.

1. **Dickieia ulvoides,** *Ralfs.* Frond entire, linear, or obovate, with a distinct pedicel; valves elliptical; nodule more or less stauriform; striæ 36 in ·001″. Length of frond ·3″ to 1·4″. Breadth of frond ·06″ to ·4″. Length of frustule ·0010″ to ·0013″. v.s.

Berk. and Ralfs, Ann. ser. 1. vol. 14. pl. ix. Prit. Anim. xxiv. 31. Kütz. Bacill. p. 119; Sp. Alg. p. 109.

Marine. Near Aberdeen, April 1844, *Dr. Dickie.*

Plate LIV. 342.

2. **Dickieia pinnata,** *Ralfs.* Frond irregularly divided; divisions rudely pinnate or laciniated; valves elliptical-lanceolate; nodule punctate. Length of frond ·3″ to 1·1″. Breadth of frond ·1″ to ·6″; striæ 40 in ·001″. Length of frustule ·0009″ to ·0011″. v.s.

Ralfs, Ann. ser. 2. vol. 8. pl. v. 6.

Marine. Near Aberdeen, Sept. 1851, *Dr. Dickie.* Cumbrae, March 1853, *Mr. Hennedy*; communicated by *Dr. Arnott.*

Plate LIV. 343.

Genus 53. **BERKELEYA**, *Grev.*

Frond gelatinous, definite, tuberculate at base, emitting towards its circumference filaments enclosing the densely-packed frustules; frustules naviculoid; valves linear-lanceolate, obtuse.

1. **Berkeleya fragilis**, *Grev.* Striæ obscure. Length of frond ·2″ to ·6″. Length of frustule ·0015″ to ·0035″. Breadth of valve ·0003″. v.v.

Grev. S. C. F. tab. 294. Grev. B. F. p. 416. Ralfs, Ann. 1 ser. vol. 16. pl. iii. 2. Kütz. Bacill. p. 109; Sp. Alg. p. 96. *Berkeleya Adriatica*, Kütz. Bacill. xxii. 4; Sp. Alg. p. 96. ad spec. authen. quæ misit am. De Brébisson. Prit. Anim. xvii. 34 & 35.

Marine. Torbay, *Mrs. Griffiths.* Cumbrae, Sept. 1853, *Mr. Hennedy*; and Oct. 1854, *Dr. Arnott.* Cork Harbour, Oct. 1855, *W. Sm.* (Cherbourg, *M. De Brébisson.* Montredon near Marseilles, May 1854, *W. Sm.*)

The tuberculate character of the frond in the present genus seems to arise from the adherence of the gelatinous filaments towards their bases, and is more or less distinct at different stages of the plant's growth. In an advanced state the adherence is less conspicuous, and the entire frond becomes filamentous. The two species given by Kützing have apparently owed their determination to this circumstance, as I can find nothing in the structure or character of the frustules to warrant the separation of *B. Adriatica* from our native form. The genus is sufficiently distinguished from its allies by the form, arrangement and structure of its frustules, which cannot be confounded with those of the filamentous species afterwards to be described. The valves are striated, as is evident from their colour, which is a very pale straw; but I have not been able to resolve the striæ so as to ascertain their number.

Plate LIV. 344.

Genus 54. **ENCYONEMA**, *Kütz.*

Frond filamentous, tubular, sparingly divided; frustules cymbelloid; valves convex, striated; striæ moniliform.

The frustules of the present genus so closely resemble those of *Cymbella*, that a superficial observer would fail to detect their true character in a prepared gathering. A careful inspection would, how-

ever, enable him to discriminate between the two, even when the frond of *Encyonema* was absent; as the terminal nodules of the median line in *Cymbella* are placed at the extremities of the valves, while in *Encyonema* they are removed to some distance above, and occupy a place nearer the central nodule of the valve.

The frond of *Encyonema* is distinctly tubular, and the frustules, which are usually in single file, except towards the extremities, where they are somewhat crowded, may often be seen to move to and fro in the interior, unimpeded by the mucus, which in *Schizonema* and other allied genera ordinarily retains them in a fixed position. I have detected conjugation in *E. prostratum.*

1. **Encyonema prostratum,** *Ralfs.* Frond nearly simple, erect or prostrate. Length of filaments ·2″ to ·5″. Extremities of valve rounded; striæ 18 in ·001″. Length of frustule ·0016″ to ·0024″. Breadth of valve ·0009″. v.v.

β. One or both extremities produced.

Ralfs, Ann. ser. 1. vol. 16. pl. iii. 3. Hass. Alg. c. 10. Prit. Anim. xvii. 22. Raben. Süssw. Diat. vii. 1. *Monema prostratum,* Berk. Brit. Algæ, iv. 3. *Schizonema prostratum,* Grev. B. F. p. 414. Var. β. *Encyonema paradoxum,* Kütz. Bacill. xxii. 1; Sp. Alg. p. 61.

Fresh water. Streams or cascades, not uncommon in the spring and summer. River Frome, Dorsetshire, June 1848; Plumpton, Sussex, April 1852, *W. Sm.* Near Glasgow, Oct. 1853; Rosthern Mere, Cheshire, Aug. 1855, *Dr. Arnott.* Lancaster, Nov. 1853 and July 1854, *Mr. Johnson.* Hornby, Lancashire, May 1853, *Mr. G. Smith.* Surrey, *Mr. Capron.* Var. β. Penzance, Nov. 1852, *Mr. Ralfs.* Plumpton, April 1852, *W. Sm.* (Chaudfontaine, Belgium, June 1851; Canal du Midi, South of France, May 1854, *W. Sm.*)

Plate LIV. 345. Sporangial frustule? 345-*a*, sp. Var. β. 345 β. *a′* & *a″*.

2. **Encyonema cæspitosum,** *Kütz.* Frond often much divided at summit, erect, tufted. Length of filaments ·2″ to ·5″; extremities of valve somewhat attenuated, obtuse; striæ 24 in ·001″. Length of frustule ·0009″ to ·0014″. Breadth of valve ·0005″. v.v.

β. One or both extremities of valve produced.

Kütz. Sp. Alg. p. 61? Raben. Süssw. Diat. vii. 5. *Encyonema prostratum,* Kütz. Bacill. xxv. 7.

Fresh water: lakes or streams. Plumpton Pond, Sussex, April 1852;

Sowley Pond, Hampshire, Sept. 1854; Dunsappie Loch near Edinburgh, Aug. 1855, *Dr. Greville.* (Canal de Crapone, South of France, May 1854, *W. Sm.*)

Some confusion in the specific name of the above has arisen from Professor Kützing regarding the cornute variety of *E. prostratum* as a distinct species, whereas the modification is only an accidental variety, and occurs intermixed in the same filament with the normal form; the same modification is also found in *E. cæspitosum*, as I have noted above, and in the gathering from the South of France was quite abundant. I refer doubtfully to Kützing for the name of the last, because his figure represents the frustule with extremities slightly pointed; still I think the same form is intended by both, and have therefore ventured to adopt his name as characteristic of the habit of the species, which grows in tufts.

Plate LV. 346.

Genus 55. COLLETONEMA, *Bréb.*

Frond simple or divided, filiform or globose; frustules sigmoid or direct, naviculoid; files containing one or more rows of scattered frustules. (All the species aquatic.)

The freshwater habitat and slightly divided frond distinguish the present genus from *Schizonema*, with which it has been confounded: the frustules of *Colletonema* are also more firmly siliceous than those of the former genus, and the character of the valve can usually be well seen after maceration in acid.

It is possible that *Pinnularia radiosa* may be merely the free state of *Colletonema neglectum*, and *Navicula crassinervia* the same condition of *Colletonema vulgare*: if future observation confirm this supposition, the species of the present genus must supplant those formerly described, and the latter be cancelled in a future edition of the present work.

1. **Colletonema eximium,** *Thw.* Frond filiform, more or less abruptly acuminate, slightly rugulose, containing one or more rows of somewhat scattered frustules; V. sigmoid, extremities rounded, striated; striæ 56 in ·001″. Length of frustule ·0025″ to ·0034″. Breadth of V. ·0005″. v.v.

Thw. Ann. ser. 2. vol. 1. pl. xii. F.

Fresh or brackish water. Bristol, Dec. 1847, *Mr. Thwaites.* Near Lewes, Sept. 1851. The Fleet, Dorsetshire, Sept. 1854, *W. Sm.*

Plate LVI. 350.

2. **Colletonema vulgare,** *Thw.* Frond filiform, occasionally divided, gradually acuminate, containing one or two rows of frustules in regular file; V. elliptical-lanceolate, slightly contracted towards the obtuse extremities; striæ 72 in ·001″. Length of frustule ·0018″ to ·0030″. Breadth of V. ·0004″ to ·00055″. v.v.

Thw. Ann. ser. 2. vol. 1. pl. xii. H.

Fresh water. Near Bristol, Dec. 1847, *Mr. Thwaites.* Near Lancaster, April 1852, *Mr. Johnson.* (Falaise, *M. De Brébisson.* Cascade de la Vernière, Mont Dore, June 1854, *W. Sm.*)

This is by no means the common species represented by Mr. Thwaites, who says that "it occurs during the spring in almost every ditch and running stream," a mistake which appears to have arisen from confounding it with the next species, which is far more general. To distinguish between the two requires the careful use of the microscope, as the form of each is so nearly alike. The principal difference is to be found in the character of the striæ, which are tolerably conspicuous in *C. neglectum,* and extremely faint and delicate in *C. vulgare.* Mr. Thwaites describes three varieties of the present species, viz. α. *rivulosum,* β. *lacustre,* γ. *effusum*; but the distinctions between them depend mainly upon the stage and place of growth; the first and last occur in streams, var. α. with a divided frond, and var. γ. forming a gelatinous covering to stones, with no appearance of separate filaments,—while var. β. is characterized by a simple filament, and is met with in still water, or where there is only a slight current: the frustules of all three are described as having "a lanceolate form, suddenly narrowed towards the apices." Not having found the species in more than one locality, I am unable to confirm this account.

Plate LVI. 351.

3. **Colletonema neglectum,** *Thw.* Filament slightly divided, obtuse, containing numerous and closely packed frustules; V. elliptical-lanceolate; extremities obtuse; striæ 32 in ·001″. Length of frustule ·0015″ to ·0024″. Breadth of valve ·00035″ to ·00045″. v.v.

Thw. Ann. ser. 2. vol. 1. pl. xii. J.

Fresh water. Near Bristol, Dec. 1847, *Mr. Thwaites.* Near Lewes, April 1851, Nov., Dec. and Jan. 1853, *W. Sm.*

Plate LVI. 352.

4. **Colletonema subcohærens,** *Thw.* Frond globose, gelatinous, pervaded by files containing from one to five rows of frustules; V. elliptical-lanceolate, with rounded extremities; striæ 28 in ·001″.

Diameter of frond from ·2″ to ·6″. Length of frustule ·0008″ to ·0015″. Breadth of V. ·00035″. v.v.

Thw. Ann. ser. 2. vol. 1. pl. xii. G.

Fresh water. North River near Wareham, Dorset, July 1847 and May 1853, *W. Sm.*

This species bears a slight resemblance in the character of its frond to *Berkeleya fragilis*, but differs in the form of its frustule and its freshwater habitat. The globose frond originates in the same way as in *Berkeleya*, by the coherence of the mucus-tubes or filaments; but, unlike that species, the mucus continues in the present to increase in volume, and always extends beyond the extremities of the rows of frustules; while in *Berkeleya* the filaments are free at their terminations, being continued beyond the mass of mucus. Conjugation has been observed in the present species, and takes place within the frond precisely in the same manner as in the free forms described under the first tribe.

Plate LVI. 353.

Genus 56. **SCHIZONEMA**, *Agardh.*

Frond gelatinous or submembranous, filiform, or by coherence leaf-like, usually much divided; frustules naviculoid, arranged in one or more files in linear series within the substance of the frond; valves elliptical, or lanceolate, striated. (All the species marine.)

The fronds in this extensive genus were among the earliest Diatomaceous organisms recognized by naturalists, and have been the perplexity of all subsequent observers. Their external form, size and colour vary with age, season and locality, and in consequence any characters based alone upon these particulars are uncertain and deceptive. Now these were the characters most relied upon by the earlier writers in their specific arrangements, and hence the descriptions of one author were often irreconcileable with those of another, and the species became inextricably confounded. Later observers endeavoured to clear up this confusion by a closer examination of the structure of the frond, and it was thought by some that the species might be arranged under two genera, as they presented one or more series of frustules included within a single gelatinous or membranous tube, or contained in secondary tubes, enclosed within a general

envelope of mucus or gelatine. But unfortunately the writers who adopted this division were neither agreed as to the names to be given to these genera, nor the species to be included under each. All the species were at first placed by Agardh in the single genus *Schizonema* ('Systema Algarum,' p. xv, 1824). By Dr. Greville, in the 'Scottish Cryptogamic Flora,' 1826 *et seq.*, those with secondary tubes were retained in *Schizonema*, and the others placed apart in the genus *Monema*. In his 'Conspectus Criticus Diatomacearum,' 1830, Agardh recognizes the distinction suggested by Greville, and places the species with uncompounded fronds in *Schizonema*, and those with secondary tubes in *Micromega*; this arrangement, though unjust to himself, was politely adopted by Greville in the 'British Flora.' Harvey, in his 'Manual of British Algæ,' reunites the species under the single genus *Schizonema*; and Kützing, in his 'Bacillarien,' 1844, and 'Species Algarum,' 1849, again divides them according to the arrangement in Agardh's 'Conspectus.' None of these methods satisfies Ehrenberg, and he invents a new name, *Naunema*, 'Infusionsthierchen,' 1838, and again unites all the species under this designation. Here are sufficient elements of confusion for future observers. This great diversity of opinion doubtless owes its origin to the variableness and inconstancy of the characters adopted by the writers, who arranged the species under two genera. The presence of only one, or of many files of frustules, is certainly to some extent dependent upon the stage of growth of the specimen examined; and the appearance of secondary tubes within the general mucus-envelope is more or less apparent in different portions of the same frond, or according as it is examined in the fresh or dry state. A very extensive comparison of specimens leads me to believe, that, in every case where the development of the frond is much advanced, as in the older or basal portions, numerous files of frustules may be discovered; and as each file, in the progress of self-division, continues to deposit fresh mucus around its frustules, the portion of the envelope in their immediate neighbourhood will be gradually consolidated and present the semblance of a tube, which will become more apparent on desiccation, as the consolidated mucus shrinks less in drying than the neighbouring portions of the frond.

Hence has arisen in some fronds rather than others an appearance

of secondary tubes, and their consequent generic separation by observers, who, principally conversant with dried specimens, have regarded this appearance of importance.

For the reasons I have just detailed, I am disposed to demur to this course, and to unite all the species under one genus, the name of which must of course be that first proposed by Agardh. I ought, however, to explain why I have not accepted the characters given by Kützing as distinctive of his two genera, viz. that the "spermatia" or reproductive bodies are external in *Schizonema*, and internal and immersed in *Micromega*. Could these characters be established, a distinction between the two genera must at once be admitted; but I believe no other observer has been able to substantiate the discoveries of Professor Kützing, and my own experience induces me to regard his "spermatia" as parasitic bodies, in no way vitally connected with the fronds on which they occur. In the only species, *S. Grevillii*, in which I have noticed conjugation, and the formation of sporangia, the process is analogous to that throughout the Diatomaceæ; and the same analogy holds good in the allied genera *Colletonema* and *Encyonema*. In all, conjugation takes place within the frond, or after the dissolution of the mucus-envelope, and follows the usual course.

The characters hitherto chiefly relied upon in specific descriptions of the *Schizonemata* also appear to me deficient in permanency, and to lead to a needless multiplication and confusion of species. Neither size, colour, nor ramification is sufficient to distinguish fronds that vary in all these respects with age, locality and exposure. A remark on this subject, made by M. De Brébisson in his 'Considérations sur les Diatomées,' 1838, p. 8, is deserving of attention, viz.:—"La plupart des espèces doivent être revues de nouveau, et étudiées avec plus de soin en ce qui concerne les frustules. On n'a pas tenu assez compte de leurs formes exactes; les espèces ont été seulement établies d'après la disposition et la couleur des frondes ou filamens, caractères trop variables." Nothing can be more just; the size, form, striation and structure of the frustules supplying far more certain elements for specific distinctions than the characters hitherto too often relied upon. Acting upon the above suggestion of M. De Brébisson, I divide the species into two sections; those of the first having frustules firmly siliceous, and fronds in consequence some-

what setaceous and robust; and the second including those species whose frustules are imperfectly siliceous, and whose fronds are flaccid and delicate in character; and while I give the size and form of the frond, generally characteristic of each species, I rely mainly for their discrimination upon the shape, size and striation of the individual frustules.

In the nomenclature of my species, I have mainly followed Harvey's 'Manual of the British Algæ,' because the genus is there more fully described than in any other English work, and because I have been enabled by the kindness of Mrs. Griffiths to examine authentic specimens of most of the species adopted by Dr. Harvey. To attempt to reduce these species to those of Kützing's, without specimens of the latter, and guided alone by the descriptions and figures in the 'Species Algarum' and 'Bacillarien,' would be to introduce further perplexity into a synonymy already sufficiently confused.

SECT. I. Frustules firmly siliceous: frond usually setaceous.

1. **Schizonema cruciger,** n. sp. Frond filiform; filaments implicate below, free above, much divided; frustules crowded; valves with a distinct stauros, lanceolate, acute; striæ distinct, 40 in ·001″. Length of frond ·1″ to 1·2″. Length of frustule ·0033″ to ·0051″. v.v.

Marine: on larger Algæ. Hove, Sussex, March 1851; Hastings, May 1852, &c., *W. Sm.* Hull, *Mr. R. Harrison.* Cumbrae, Feb. 1854, *Mr. R. Hennedy.*

Plate LVI. 354. Plate LVII. 356.

2. **Schizonema helmintosum,** *Chauv.* Frond filiform, or by cohesion irregularly submembranous, much and irregularly divided; ultimate divisions short, abrupt; frustules in single files or crowded; valves elliptical; striæ 48 in ·001″. Length of frond ·5″ to 2″. Length of frustule ·0014″ to ·0019″. v.v.

Ag. Consp. Crit. p. 20. Grev. B. F. p. 412. Harv. Man. p. 210. ad specim. authen.

Marine: on rocks. Torbay, *Mrs. Griffiths.* Aberdeen, *Dr. Dickie.* Poole Bay, Sept. 1851; Coast of Sussex, frequent, *W. Sm.* Isle of Arran, Aug. 1853; Frith of Clyde, March 1854, *Dr. Arnott.* Exmouth, *Miss Cutler.*

The valves are often somewhat acute, and not with rounded apices as in the figure.

Plate LVI. 355.

3. **Schizonema comoides,** *Ag.* Frond filiform, simple below, much divided and fasciculated above; frustules crowded; valves lanceolate; striæ 48 in ·001″. Length of frond ·5″ to 1·5″. Length of frustule ·0008″ to ·0013″. v.v.

Ag. Consp. p. 19. Harv. Man. p. 213. ad specim. authen.

Marine: on rocks, or mud banks. Torbay, *Mrs. Griffiths.* Aberdeen, *Dr. Dickie.* Coast of Sussex, March 1854, *W. Sm.*

Plate LVII. 358.

4. **Schizonema confertum,** n. sp. Frond filiform, sparingly divided throughout; frustules exceedingly crowded; valves lanceolate, acute; striæ marginal, indistinct. Length of frond ·1″. Length of frustule ·0008″ to ·0011″. v.s.

Schizonema implicatum, Harv. sic Dr. Dickie in lit.

Marine. Aberdeen, *Dr. Dickie.*

This is certainly not *S. implicatum,* Harv., the valves being different both in form and striation.

Plate LVII. 359.

5. **Schizonema mucosum,** *Kütz.* Frond filiform, gelatinous, simple below, by cohesion submembranous above, margin irregularly ramulous; frustules in files, few, subdistant; valve elliptical, delicately striated. Length of frond ·2″. Length of frustule ·0009″ to ·0013″. v.v.

Kütz. Bacill. p. 115. tab. xxvi. 9.

Marine: in muddy pools. Hove, near Brighton, April 1854, *W. Sm.*

I cannot refer this species to any in the 'Manual,' and have ventured to adopt Kützing's name, as my specimens coincide in most particulars with the description and figure of *S. mucosum* given in the 'Bacillarien.'

Plate LVII. 360.

6. **Schizonema Smithii,** *Ag.* Frond filiform, robust, simple below,

much divided, fasciculated, and fastigiate above; frustules in numerous closely-set files; valve elliptico-lanceolate, acute; striæ 40 in ·001″. Length of frond 1″. Length of frustule ·0015″ to ·0022″. Breadth of valve ·0003″. v.v.

Ag. Consp. p. 18. ad specimina authentica in herb. Grev. Grev. S. C. F. tab. 298. Grev. B. F. p. 413. Harv. Man. p. 211. ad specim. authen. Kütz. Bacill. xxvii. 5. ad specimina quæ dedit. cl. De Brébisson.

Marine: on rocks. Torbay, *Mrs. Griffiths* and *Mrs. Wyatt*. Swanage, Dorsetshire, March 1849; Newhaven, Sussex, Oct. 1853, &c., *W. Sm.* Burntisland Sands, and Joppa near Edinburgh, Oct. 1853, *Dr. Greville*. Sidmouth and Exmouth, *Miss Cutler*.

Plate LVII. 362.

7. **Schizonema torquatum,** *W. Sm.* Frond filiform, simple below, much divided, and fasciculated above, ultimate divisions exceedingly twisted; frustules subdistant, in numerous files; valve lanceolate; striæ 40 in ·001″. Length of frond 1·5″. Length of frustule ·0009″ to ·0012″. Breadth of valve ·00035″. v.v.

Schizonema Smithii β. torquatum, Harv. Man. p. 211. ad specimina authentica.

Marine: on rocks, or larger Algæ. Torbay, *Mrs. Griffiths*. Poole Bay, Sept. 1849, *W. Sm.* Exmouth, June 1854, *Miss Cutler*. Joppa near Edinburgh, *Dr. Greville*.

It is not improbable, as Dr. Harvey suggests, that the present species is a variety of *S. Smithii*; but as the contorted character of its ultimate ramuli gives it a very characteristic appearance, and its frustules are shorter and more slender than those of *S. Smithii*, I have thought it better to figure and describe it as distinct.

Plate LVII. 361.

8. **Schizonema divergens,** n. sp. Frond simple below, sparingly divided, or by cohesion irregularly submembranous above; ultimate ramuli short, obtuse; striæ 42 in ·001″. Length of frond 1″. Length of frustule ·0013″ to ·0018″. Breadth of valve ·00035″. v.s.

Marine. Larne Lough, in five fathoms, Sept. 1853, *Dr. Dickie*.

The specimens supplied by the discoverer were remarkable for the diffused arrangement of the primary divisions; hence the name I have adopted: the species is closely allied to the last two.

Plate LVII. 363.

9. **Schizonema Grevillii,** *Ag.* Frond filiform, much divided from the base; ultimate ramuli acute; larger divisions with several files, ultimate ramuli with a single file of frustules; valve lanceolate; striæ 60 in ·001″. Length of frond ·5″ to 1·5″. Length of frustule ·0017″ to ·0025″. Breadth of valve ·00055″. v.v.

Ag. Consp. p. 19. ad specimina authentica in herb. Grev. Grev. B. F. p. 413. *Schizonema quadripunctatum* et *S. Grevillii*, Harv. Man. p. 214. ad specimina authentica. *S. Grevillii*, Kütz. Bacill. v. 1. & xxvi. 4. ad specim. quæ dedit cl. De Brébisson. *Bangia quadripunctata*, Lyng. Tent. 26?

Marine. Torbay, *Mrs. Griffiths* and *Mrs. Wyatt*. Pevensey Bay, Sussex, Sept. 1850 and May 1852; Hove, Sussex, March 1851, *W. Sm.* Saltcoats, March 1854, *Dr. Arnott*. Frith of Forth, *Dr. Greville*.

The large, and on the F. V. nearly square frustules of this remarkable species are not likely to be confounded with those of any other *Schizonema*, and enable me to give the above synonymy with tolerable confidence.

Plate LVIII. 364.

10. **Schizonema molle,** n. sp. Frond gelatinous, simple below, membranous by cohesion above; margin much divided into acute segments; frustules in crowded files; valves lanceolate, acute; striæ 48 in ·001″. Length of frond ·6″. Length of frustule ·0012″ to ·0015″. Breadth of valve ·00045″. v.s.

Marine. Coast of Aberdeen, 1847, *Dr. Dickie*. Exmouth, July 1854, *Miss Cutler*.

I cannot reduce this species to any of the previous, nor to any form given in Harvey's 'Manual.' The frustules are very like those of *S. helmintosum*, but the form and structure of the frond are altogether different: in general character, the frond belongs to the next section, being soft and flaccid, but the frustules are firmly siliceous, and resist the action of acid.

Plate LVIII. 365.

Sect. II. Frustules imperfectly siliceous; striæ obscure; frond flaccid.

11. **Schizonema Dillwynii,** *Ag.* Frond capillary throughout, sparingly branched, tenacious, apices acute; frustules exceedingly crowded towards the apices, scattered and remote in the older portions; valves lanceolate, acute. Length of frond 2″ to 5″ or

upwards. Length of frustule ·0008″ to ·0011″. Breadth of valve ·0002″. v.v.

Var. β. Filaments dark-coloured, much branched, and very tenacious.

Ag. Syst. p. 10. ad specim. authen. in herb. Grev. Ag. Consp. p. 20. Grev. B. F. p. 412. Harv. Man. p. 212. ad specim. authen. Kütz. Bacill. xxvi. 3. ad specim. quæ dedit cl. De Brébisson. *Monema Dillwynii*, Grev. S. C. F. tab. 297. *Conferva fœtida*, Dill. Conf. tab. 104.

Marine: attached to larger Algæ. Torbay, *Mrs. Griffiths*. Near Bristol, July 1845, *Mr. Thwaites*. Aberdeen, *Dr. Dickie*. Brodrick Bay, August 1853, *Dr. Arnott*. Kinghorn, Fife, September 1853, *Dr. Greville*. North Fleet, *Mr. Shadbolt*. Poole Bay, December 1847 and June 1849; Hove, Sussex, November 1851; Seaford, February 1852; Cork Harbour, November 1855, &c., *W. Sm.*

A widely distributed species, often occurring in salt-marshes in enormous quantities, and easily recognized by its long flaccid tenacious filaments, like tufts of fine chestnut-coloured hair. Var. β. occurs in running water, and is in no way different from the ordinary form, except in its more profuse ramifications and darker colour; in mass it is almost black.

Plate LVIII. 366.

12. **Schizonema implicatum,** *Harvey.* Frond capillary, much branched, entangled, and implicate throughout; ultimate ramuli long; frustules irregularly crowded; V. lanceolate, obtuse. Length of frond 3″. Length of frustule ·0009″ to ·0012″. Breadth of valve ·0003″. v.s.

Harv. Man. p. 213. ad specim. authen.

Marine. Salcombe, *Mrs. Griffiths*.

Plate LIX. 367.

13. **Schizonema obtusum,** *Grev.* Frond filiform, sparingly branched; apices abrupt; frustules exceedingly numerous, in irregular files; valves elliptical. Length of frond 1″. Length of frustule ·0011″. Breadth of valve ·00025″. v.s.

Grev. B. F. p. 413. Harv. Man. p. 209. ad specimina authentica.

Marine; on larger Algæ. Torbay, *Mrs. Griffiths*. West Coast of Scotland, *Dr. Arnott*.

Plate LVIII. 368.

14. **Schizonema ramosissimum,** *Ag.* Frond filiform, much divided

from the base, and irregularly submembranous by cohesion above; ramuli short, obtuse; frustules very numerous in closely packed files; valves elliptico-lanceolate, acute. Length of frond 1″ to 1·5″. Length of frustules ·0009″. Breadth of valve ·0002″. v.s.

Ag. Syst. p. 11. Harv. Man. p. 210. ad specim. authen. *Micromega ramosissimum*, Ag. Consp. p. 22.

Marine. Salcombe, *Mrs. Griffiths*. Kinghorn, Fife, October 1853, *Dr. Greville*. Swanage, Dorset, April 1847; Coast of Sussex, March and August 1852, *W. Sm.*

Plate LIX. 369.

15. **Schizonema laciniatum,** *Harvey*. Frond filiform, much branched; filaments often cohering into rope-like tufts; ramuli very long; frustules numerous, crowded in irregular files; valves elliptical, somewhat acute. Length of frond 1″ to 3″. Length of frustule ·0013″. Breadth of valve ·00035″. v.v.

Harv. Man. p. 210. ad specim. authen.

Marine: on rocks. Torbay, *Mrs. Griffiths*. Minehead and Isle of Arran, Sept. 1853, *Dr. Arnott*. Seaford, Sussex, April 1850, *W. Sm.* Joppa near Edinburgh, *Dr. Greville*.

Plate LIX. 370.

16. **Schizonema parasiticum,** *Harvey*. Frond capillary, branched; filaments slightly cohering above; ramuli short, patent, mucus often rugose; frustules crowded in files more or less distant; valves elliptico-lanceolate, acute. Length of frond ·5″ to 1″. Length of frustule ·0011″. Breadth of valve ·0002″. v.v.

Harv. Man. p. 213. ad specim. authen.

Marine: attached to other Algæ. Torbay, *Mrs. Griffiths*. Aberdeen, *Dr. Dickie*. Cuckmere Harbour, Sussex, April 1852; Beachey Head, April 1853; Ballycottin Bay, Co. Cork, May 1853, *W. Sm.* Joppa near Edinburgh, *Dr. Greville*.

Plate LIX. 371.

17. **Schizonema gracillimum,** n. sp. Frond capillary, simple below, sparingly branched and submembranous towards the apices; frustules crowded in irregular files; valves elliptico-lanceolate,

acute. Length of frond 1″. Length of frustule ·0009″. Breadth of valve ·00015″. v.s.

Marine. Tor Abbey Rocks, April 1842, *Mrs. Griffiths.*

Plate LIX.,372.

Genus 57. HOMŒOCLADIA, *Ag.*

Frond filiform, sparingly divided; frustules nitzschoid, usually somewhat fasciculated; striæ obscure.

The structure of the frustules, which is that of the genus *Nitzschia*, separates the present from the other genera of the tribe. The species are all marine, and appear to be rare, as few British localities are known to me, or have been given by former authors.

1. **Homœocladia Martiana,** *Ag.* Frond simple, or dichotomously divided, rugose; height of frond ·3″ to ·7″; frustules usually in dense fascicles, on F. V. linear-lanceolate, obtuse; V. linear, obtuse. Length of frustule ·0120″. Breadth of valve ·0002″. v.s.

Ag. Consp. p. 25. ad sp. authen. in herb. Grev. Kütz. Bacill. xxx. 83. Sp. Alg. 98. Prit. Anim. xvii. 47–49. *Homœocladia Anglica*, Ag. Consp. p. 25. Kütz. Bacill. xxx. 82. Ralfs, Ann. 1st ser. vol. 16. iii. 1. "Wrongly described in the 'Annals' as *H. Anglica*," cl. Ralfs, in lit. Nov. 1852.

Marine. Torquay, *Mrs. Griffiths.* Ilfracombe, Sept. and Oct. 1844, *Mr. Ralfs.* (Coast of Normandy, *M. De Brébisson.*)

A rare form, which has been described, as will be seen above, under the two designations of *Anglica* and *Martiana*; the specimens which I have seen thus variously marked all belong to one species, and I have Mr. Ralfs' authority for referring his *H. Anglica* to the older designation of Agardh.

Plate LV. 347.

2. **Homœocladia filiformis,** n. sp. Frond linear, simple; fascicles containing three or four frustules; height of frond ·2″ to ·3″; F. V. linear-lanceolate, obtuse; V. linear-lanceolate, somewhat acute. Length of frustule ·0043″. Breadth of V. ·0003″. v.v.

β. A smaller form. Length of frustule ·0018″. Breadth of V. ·0002″. v.v.

Brackish water. Bexhill, Sussex, Sept. 1850; β. Near Lewes, Aug. 1852, *W. Sm.*

Plate LV. 348. Var. β. Plate LV. 348.β.

3. **Homœocladia sigmoidea,** n. sp. Frond linear, simple; frustules irregularly fasciculated in bundles of about six; F. V. sigmoid; V. linear, attenuated towards the extremities. Height of frond ·3″ to ·6″. Length of frustule ·0025″. Breadth of valve ·0002″. v.v.

Brackish water: attached to grass. Near Wareham, Dorset, Jan. 1850, *W. Sm.*

Plate LV. 349.

Suppl. Genus 58. **ASTERIONELLA,** *Hass.*

Frustules linear, inflated towards one or both extremities; adhering by their adjacent angles into a star-like filament.

The present genus, first constituted by Mr. Hassall in his pamphlet "Microscopic Examination of the Water supplied to the Inhabitants of London," was not known to me when I arranged the genera of the present work. It ought probably to be placed next after *Diatoma*, as it agrees with that genus in the general form of its frustules, differing from it chiefly in the mode of adherence which takes place after self-division.

The species which have reached me through the kindness of the correspondents mentioned below were none of them in a satisfactory condition for examination, and it would require a further acquaintance with them in a fresh state to clear up several points in their habit and structure.

1. **Asterionella formosa,** *Hass.* Star of from four to eight frustules; on F. V. somewhat more enlarged at the base (point of adherence) than at the summit. Length of frustule ·0021″ to ·0031″. v.s.

Hass. *l. c.* p. 10, &c.

Fresh water: in water supplied to the town of Tenby, March 1853, *Mr. Roper.* Rosthern Mere, Cheshire, Sept. 1855, *Dr. Arnott.*

2. **Asterionella Ralfsii,** *W. Sm.* Frustules on F. V. exactly linear; valve attenuated towards one extremity, constricted towards the other, which is rounded and capitate; striæ obscure. Length of frustule ·0018″. v.s.

Diatoma stellare, Ralfs, MSS. ad specim. in Herb. Jenn.

3. **Asterionella Bleakeleyii**, n. sp. Frustules linear, enlarged at the base. Length of frustule ·0022″. v.s.

Marine. Harwich, May 1853, *Mr. Bleakeley*.

The meagreness of the above descriptions, the fullest I can give from the dried specimens in my hands, leaves much to be done by more fortunate observers.

I am, however, tolerably certain of the distinctness of the three forms, *A. Ralfsii* being obviously different from the other two, and the habitat of *A. Bleakeleyii* placing it apart from *A. formosa*, to which it otherwise bears a close resemblance.

APPENDIX.

A.

Since the publication of the first volume of the Synopsis, the following British forms belonging to genera therein described have been discovered or detected by various observers, and seem entitled to rank as distinct species, or as well-marked varieties.

1. **Eunotia bidentula,** *W. Sm.* Frustule direct; valve with two prominent, acute, or rounded dorsal ridges; basal margin straight, extremities produced; striæ indistinct, 42 in ·001″. Length ·0008″ to ·0015″. v.v.

Eunotia Camelus?, Ehr. in Grev. Ann. 2nd ser. vol. 15. pl. ix. 1.

Fresh water. Braemar, August 1854, *Dr. Balfour.* Fell-end near Lancaster, Aug. and Oct. 1854, *Mr. Johnson.* Arran, July 1854, *Dr. Arnott.* Barley Lough near Glengariffe, Co. Cork, June 1855, *W. Sm.*

The figure in the 'Microgeologie,' xxxix. 15, of *E. Camelus*, Ehr., shows that the present cannot be that species.

2. **Eunotia tridentula,** *Ehr.* Frustule arcuate; valve with three slight dorsal elevations; striæ obscure. Length ·0005″. Breadth of valve ·0002″. v.s.

Ehr. in Kütz. Bacill. xxix. 60; Microg. xxxix. ii. 51. xv. B. 29. Grev. Ann. 2nd ser. vol. 15. pl. ix. 2. Greg. Mic. Journ. vol. 4. pl. i. 1. *Eunotia crenulata,* Bréb. ad specimina quæ misit cl. Auctor.

Fresh water. Fell-end, Lancashire, May 1851, *Mr. Johnson.* Braemar, Aug. 1854; *Dr. Balfour.*

3. **Eunotia quaternaria,** *Ehr.* Frustule arcuate; valve with four

slight dorsal elevations; striæ obscure. Length ·0007″. Breadth of valve ·0002″. v.s.

Ehr. in Kütz. Bacill. xxix. 59; Microg. xxxv. A. ii. 10. Grev. Ann. 2nd ser. vol. 15. pl. ix. 3.

Fresh water. With the last species, and probably only an advanced state of it.

4. **Cymbella ventricosa,** *Kütz.* Dorsal (larger) segment of V. regularly convex, basal linear, margin plane; striæ 30 in ·001″. Length ·0006″ to ·0011″. Breadth of V. ·00025″. v.v.

Kütz. Bacill. vi. 16.

Fresh water: frequent. Cockshut Stream, Lewes, May 1853, &c., *W. Sm.* Derbyshire, May 1853, *Dr. Redfern.* Queen's Park, Edinburgh, April 1854, *Dr. Greville.* Lough Leven, Aug. 1854, *Dr. Gregory.* Haverfordwest, Aug. 1855, *Mr. Okeden.* (Langogne, in the Cevennes, elevation 4000 feet, June 1854, *W. Sm.*)

5. **Cymbella Helvetica,** *W. Sm.*

Var. β. Extremities obtuse, or rounded. v.v.

Fresh water: very frequent. Near Menai Bridge, July 1853, *W. Sm.*

Probably the most usual form of this species: hardly to be distinguished from detached frustules of *Cocconema cymbiforme*, as figured in 'Synopsis,' xxviii. 220.

6. **Cymbella Scotica,** *W. Sm.*

Var. β. With obtuse or rounded extremities; striæ 42 in ·001″. v.v.

Fresh water: often intermixed with *C. Scotica*, α. Braemar, Aug. 1854, *Dr. Balfour*, very plentifully.

The number of striæ, in Vol. i. p. 18, is wrongly stated at 32 in ·001″. This species comes very near *C. delicatula*, Kütz. Sp. Alg. p. 59.

7. **Cymbella æqualis,** *W. Sm.* Valve nearly direct, and symmetrical, slightly curved at the produced and obtuse extremities; striæ 30 in ·001″. Length ·0013″ to ·0015″. Breadth of V. ·0003″. v.s.

W. Sm. in Grev. Ann. 2nd ser. vol. 15. pl. ix. 4.

Fresh water. Braemar, Aug. 1854, *Dr. Balfour.* New Forest, Hampshire, Sept. 1854, *W. Sm.*

8. **Cymbella lunata,** *W. Sm.* Frustule lunate; dorsal segment of

valve regularly convex; margin of basal segment slightly concave; striæ 24 in ·001″. Length ·0013″. Breadth of valve ·00025″. v.s.

W. Sm. in Grev. Ann. 2nd ser. vol. 15. pl. ix. 5.

Fresh water. Braemar, Aug. 1854, *Dr. Balfour*.

9. **Cymbella Arcus**, *Greg.* Dorsal segment of valve much larger than basal, convex, with a slight central elevation; margin of basal segment plane; nodule submarginal, extremities produced, capitate; striæ 40 in ·001″. Length ·0014″. Breadth of V. ·0002″. v.s.

Greg. Mic. Journ. vol. iv. pl. 1. 21.

Fresh water. Near Hamilton, *Dr. Gregory*; communicated by *Dr. Arnott*.

10. **Amphora affinis**, *W. Sm.*

Var. β. Extremities produced. v.s.

Amphora Arcus, Greg. Mic. Journ. vol. 3. pl. iv. 4. v.s.

Brackish water. Lough of Skaill, Orkney, Aug. 1855, *Rev. J. Pollexfen*; communicated by *Dr. Greville*.

11. **Coscinodiscus concinnus**, n. sp. Cellules arranged in radiating lines, equal except in centre of valve, where there occur three to eight larger cellules; cellules 24 in ·001″. Diameter ·0025″ to ·0056″. v.v.

Marine. Stomach of Pecten, Coast of Sussex, Feb. 1854, and Kinsale Bay, April 1855, *W. Sm.* Frith of Clyde, Nov. 1854, *Mr. Hennedy*. Cumbrae, Feb. 1855, *Dr. Arnott*.

This may be *C. centralis*, Ehr. in Kütz. Sp. Alg. p. 123; but the figure of that species in Microg. xviii. 39 has a distinct marginal ring, which is wanting in my specimens; moreover, the cellules in *C. concinnus* are too minute to have been detected by the instrument used by Ehrenberg.

12. **Coscinodiscus perforatus**, *Ehr.* Cellules in radiating lines, equal, centre smooth; 9 cellules in ·001″. Diameter up to ·01″ (*Roper*, in lit.). v.s.

Marine. Thames mud, Aug. 1854, *Mr. Roper*. Medway, March 1854, *Mr. Dallas*.

I need hardly say that there is no perforation in the centre of the valve, as the name would imply.

13. **Eupodiscus Ralfsii**, *W. Sm.* Cellules in radiate series, forming distinct zones; process (?) single, submarginal; valve iridescent; cellules 18 in ·001″. Diameter ·0018″ to ·0042″. v.v.

Marine. Ilfracombe, June 1853, *Mr. Ralfs.* Cumbrae, Frith of Clyde, Feb. 1854, *Mr. Hennedy.* (Cherbourg, *M. De Brébisson.*)

This species, together with *E. fulvus* and *E. crassus* of the present work, probably belong to the genus *Actinocyclus*, Ehr.; but as I have limited that genus to frustules with undulated valves, I am obliged to place these apart. Their position in *Eupodiscus* is, however, doubtful, as the process in all is rather a pseudo-nodule than a projection from the surface of the valve.

The lines of cellules in the present species diminish in number at distinct intervals from the margin towards the centre of the valve, giving a zoned appearance to its surface when seen under a low power, the lines that reach the centre dividing the area of the valve into apparent rays of cellules.

The colour under a low power is a rich iridescent purple of various hues.

I have carefully examined various Guanos containing discs of Ehrenberg's multitudinous species of *Actinocyclus*, but cannot satisfy myself that the present is precisely identical with any figured in the 'Microgeologie': in no case does Ehrenberg notice the pseudo-nodule, which he could hardly have overlooked.

14. **Actinocyclus duodenarius**, *W. Sm.* Valve with twelve rays. Diameter ·0037″, &c. v.s.

Actinoptýcus duodenarius, Ehr. in Kütz. Sp. Alg. p. 131; Microg. xviii. 24.

Marine. Medway, March 1854, *Mr. Dallas.*

15. **Actinocyclus sedenarius**, *Roper.* Valve with sixteen rays. Diameter ·0048″, &c. v.s.

Roper, Mic. Trans. vol. 2. pl. vi. 2. *Actinoptycus sedenarius*, Ehr. in Kütz. Sp. Alg. p. 131; Microg. xviii. 26. Kütz. Bacill. i. 23.

Marine. Medway, *Mr. Dallas.* Thames, *Mr. Roper.* Near Caermarthen, Aug. 1854, *Mr. Okeden.*

16. **Actinocyclus octodenarius**, *W. Sm.* Valve with eighteen rays. Diameter ·0054″, &c. v.s.

Actinoptycus octodenarius, Ehr. in Kütz. Sp. Alg. p. 131.

Marine. Medway, *Mr. Dallas.*

The last three forms are probably the same species in different stages of growth. I have placed them all in *Actinocyclus*, for in all the surface of the

valve is ridged or waved. The genus *Actinoptycus* of Ehrenberg is only distinguished from *Actinocyclus* by the presence of internal septa: these do not exist in any specimens I have seen, and, I am disposed to believe, are in no case present in frustules of this kind.

17. **Triceratium exiguum,** n. sp. Cellules circular; angles produced into linear and truncated processes. Distance between the angles ·0005″. v.v.

Fresh water. Ormesby, Norfolk, Aug. 1853, *Mr. Bridgman.*

This beautiful little form is remarkable as being the only freshwater species of the genus.

18. **Triceratium striolatum,** *Ehr.* Cellules circular, distinct, in subradiate series; margin of valve convex; angles produced into short subconical truncate processes. v.s.

Ehr. in Kütz. Bacill. xvii. 10. Roper, Mic. Trans. vol. 2. pl. vi. 3.

Marine. "Thames mud," *Mr. Roper.*

The species described in the present work, Vol. i. p. 27, is probably *T. undulatum,* Ehr.

19. **Triceratium armatum,** *Roper.* Cellules circular, irregularly arranged; margin of valve concave; angles produced, subcapitate. v.s.

Roper, Mic. Journ. vol. ii. p. 283. fig. 1.

Marine. Milford Haven, July 1854, *Mr. Okeden.*

20. **Cyclotella punctata,** n. sp. F. V. with undulations; valves delicately punctate or cellulate; cellules radiate. Diameter ·0008″ to ·0015″. v.s.

Fresh water. Near Wisbeach, Dec. 1853, *Mr. S. Smith.*

21. **Cyclotella Dallasiana,** n. sp. Margin of valve costate; centre cellulate; cellules irregular. Length of costæ ·0002″. Diameter of valve ·0022″. v.s.

Marine? Medway, *Mr. Dallas.*

The single specimen of this species in balsam, communicated by Dr. Greville, leaves much in uncertainty respecting its true character.

22. **Campylodiscus bicostatus,** *W. Sm.* Valve suborbicular; canaliculi from twenty to thirty, interrupted, not reaching centre of valve. Diameter ·0015″ to ·0022″. v.s.

W. Sm. in Roper, Mic. Trans. vol. 2. pl. vi. 4.

Marine. Thames mud, *Mr. Roper.* Breydon, Norfolk, July 1853, *Mr. Bridgman.* Northfleet, Sept. 1854, *Mr. Capron.*

23. **Campylodiscus Clypeus,** *Ehr.* Valve suborbicular; canaliculi from 40 to 100, irregularly interrupted, reaching over two-thirds of the radius; ridges of canaliculi, and two bands in centre of valve, punctate. Diameter ·0042″ to ·0098″. v.v.

Ehr. in Kütz. Bacill. pl. ii. 5; in Prit. Anim. xii. 516. Microg. x. B. &c.

Brackish water. Breydon, Norfolk, Sept. 1854, *Mr. Wigham.* Swansea Dock, at the depth of 25 feet, Oct. 1854, *Mr. Okeden.*

The last two species are closely allied, but an inspection of specimens of both will satisfy any one of their distinctness.

The occurrence of *Campylodiscus Clypeus* in a living state is an interesting fact, as hitherto it has only occurred in deposits.

24. **Surirella apiculata,** n. sp. Valve elliptical, ovate; smaller extremity produced into a linear, truncate apiculum; canaliculi 15 in ·001″. Length of frustule ·0008″ to ·0012″. v.v.

Fresh water. Haverfordwest, April 1854, *Mr. Okeden.* Newhaven, Sussex, Nov. 1854, *W. Sm.*

A close ally, if not a variety of *S. angusta.*

25. **Surirella Amphioxys,** n. sp. F. V. linear; V. elliptical-lanceolate, extremities subacute; canaliculi 9 in ·001″. Length of frustule ·0012″. Breadth of valve ·0005″. v.v.

Fresh water. Haverfordwest, August 1855, *Mr. Okeden.*

26. **Surirella Crumena,** *Bréb.* V. suborbicular; striæ obscure; canaliculi 15 in ·001″. Length of frustule ·0009″. Breadth of valve ·0008″. v.v.

Bréb. in Kütz. Sp. Alg. p. 38.

Fresh water. River Avon, Lanarkshire, July 1854, *Dr. Gregory.* Near Tantallon Castle, August 1854, *Dr. Greville.*

S. Brightwellii (Synop. pl. ix. 69), which M. De Brébisson was at first disposed to regard as identical with this species, is distinguished from it by its coarser and more prominent costæ and distinct striæ. The outline of both species is nearly alike; *S. Crumena* is, however, a smaller and more orbicular form.

27. **Tryblionella levidensis,** n. sp. V. linear, subacute at the extremities; canaliculi very distinct, parallel, extending to the central line, 5 in ·001″. Length of frustule ·0012″ to ·0017″. v.v.

Brackish water. Cork City Park, April 1855, *W. Sm.*

28. **Tryblionella constricta,** *Greg.* V. fiddle-shaped, apiculate; canaliculi obsolete; striæ delicate, 40 in ·001″. Length of frustule ·0008″ to ·0011″. v.v.

Greg. Mic. Journ. vol. 3. pl. iv. 13. *T. Soleiformis,* W. Sm. MSS.

Marine. Stomach of Pecten, Coast of Sussex, Feb. 1853, and Kinsale Bay, April 1855; Poole Bay, Sept. 1849; Cork Harbour, Aug. 1855, *W. Sm.* Glenshira Sand, *Dr. Gregory*; communicated by *Dr. Arnott,* March 1855. (Near Marseilles in the Mediterranean, May 1854, *W. Sm.* Ceylon, *Dr. Kelaart.*)

The surface of the valve in this species is striated as in *Pleurosigma angulatum*: the form is precisely that of *Cymatopleura apiculata.*

29. **Nitzschia Palea,** *W. Sm.* F. V. linear; valve linear-lanceolate with acute extremities. Length of frustule ·0008″ to ·0016″. v.v.

Synedra Palea, Kütz. Bacill. iii. 27, iv. 2. *Synedra Fusidium,* Kütz. Bacill. xxx. 33. ad specimina authentica quæ misit cl. De Brébisson.

Fresh water: not unfrequent. Lewes, April 1853, &c., *W. Sm.* Haverfordwest, Oct. 1855, *Mr. Okeden.* (Avignon, May 1854, *W. Sm.* Falaise, *M. De Brébisson.*)

My specimens from Avignon, named *S. Palea* by M. De Brébisson, correspond with authentic specimens of *S. Fusidium* from Falaise, sent by the same kind friend.

30. **Nitzschia linearis,** *W. Sm.*

Var. β. Valve elliptical-lanceolate. Length of frustule ·0018″ to ·0031″. v.s.

Fresh water. Derbyshire, Aug. 1853, *Dr. Redfern.*

A common variety; probably the earlier condition of the frustule.

31. **Nitzschia curvula,** *W. Sm.* F. V. linear, tapering towards the

truncated extremities; V. linear-acute; striæ obscure. Length of frustule ·0033″ to ·0058″. v.v.

Navicula curvula, Ehr. Inf. xiii. 14? Kütz. Bacill. iv. 31? *Nitzschia Sigmatella*, Greg. Mic. Journ. vol. 3. pl. iv. 2.

Fresh water. Poole Bay, Sept. 1854; New Forest, Hampshire, Sept. 1854; Lough Avaul, Co. Cork, June 1855, *W. Sm.* Elchies, Bamffshire, Aug. 1854, *Dr. Gregory*.

Almost identical in form with *N. Sigma*, but distinguished from that species by its far more delicate striæ and freshwater habitat.

32. **Amphiprora elegans**, n. sp. F. straight; F. V. lanceolate, constriction very slight; V. lanceolate; striæ 40 in ·001″. Length of frustule ·0088″ to ·0124″. v.v.

Marine. Harwich, July 1853, *Mr. Bleakeley*. Milford Haven, March 1854, *Mr. Roper*. Salt Pans, Hampshire, Sept. 1854; Cork Harbour, June 1855, &c., *W. Sm.*

Distinguished from *A. vitrea* by its longer and, comparatively, more lanceolate and slender frustule and closer striæ.

33. **Amphipleura inflexa**, *Bréb.* Frustule arcuate, linear, slightly attenuated towards the rounded extremities; striæ 52 in ·001″. v.s.

Bréb. in Kütz. Sp. Alg. p. 88. ad specimina authentica quæ misit cl. collector.

Marine. Ilfracombe, *Mr. Ralfs*; communicated by *M. De Brébisson*. (Coast of Normandy, *M. De Brébisson*.)

34. **Navicula rhomboides**, *Ehr.*

Var. β. V. elliptical-lanceolate; extremities rounded. v.v.

Fresh water: frequent with Var. α. New Forest, Hampshire, Sept. 1854, *W. Sm.* Near Lancaster, Aug. 1853, *Mr. Johnson*. Ben Lomond, Sept. 1854, *Dr. Arnott*. Elchies, Bamffshire, Aug. 1854, *Dr. Gregory*.

35. **Navicula firma**, *Kütz.*

Var. γ. Extremities cuneate. v.s.

Navicula amphigomphus, Ehr. in Kütz. Bacill. xxviii. 40. et *Nav. microstoma*, Kütz. Sp. Alg. p. 71. ad specim. quæ misit am. De Brébisson.

Fresh water. Lough Leven, Aug. 1854, *Dr. Gregory*.

The semblance of a marginal band in this, and some allied forms, appears to arise from the bending inwards of the edges of the valves towards the line of suture.

36. **Navicula pygmæa,** *Kütz.* V. elliptical-oblong, subacute. Length ·0012″. Breadth of V. ·0005″. v.v.

Kütz. Sp. Alg. p. 77. ad specim. quæ dedit cl. De Brébisson.

Brackish water. Itford, Sussex, Nov. 1853; Cork Harbour, Nov. 1855, *W. Sm.* Coast of Norfolk, *Mr. Bleakeley* and *Mr. Bridgman.*

Differs from *N. minutula,* Synop. vol. i. xxxi. 274, only in the greater comparative length and subacuteness of valve: that species must therefore yield place to the present, and be described in future as *N. pygmæa* var. *β.*

37. **Navicula Scutelloides,** *W. Sm.* Valve nearly orbicular; striæ moniliform, 18 in ·001″. Length of F. ·0007″. Breadth of V. ·0006″. v.v.

W. Sm. in Greg. Mic. Journ. vol. iv. p. 4. pl. i. 15.

Fresh water. Ormesby, Norfolk, Sept. 1853, *Mr. Bridgman.* Rosthern Mere, Cheshire, Sept. 1855, *Dr. Arnott.* Cantyre Peat, &c.

38. **Navicula Bacillum,** *Ehr.* V. linear, extremities rounded; striæ 54 in ·001″. Length of F. ·0011″ to ·0022″. Breadth of V. ·0005″. v.s.

Ehr. in Kütz. Bacill. xxviii. 69. ad specim. authen. quæ dedit am. De Brébisson. *Nav. bacillaris,* Greg. Mic. Journ. vol. 4. pl. i. 24.

Fresh water. Dundee, Dec. 1855, *Dr. Gregory.*

39. **Navicula lævissima,** *Kütz.* V. linear, or slightly inflated at centre; extremities truncate; striæ 48 in ·001″. Length of valve ·0008″ to ·0019″. Breadth of valve ·00025″ to ·0005″. v.v.

Kütz. Bacill. xxi. 14. *Stauroneis rectangularis,* Greg. Mic. Journ. vol. 2. pl. iv. 17.

Fresh water: frequent. Lewes, March 1853 and April 1854; Glengariff, Co. Cork, June 1855, &c., *W. Sm.* Lough End near Edinburgh, March 1854, *Dr. Gregory.* Bridge of Allan, *Dr. Arnott.* Ulverstone, Dec. 1854, *Miss Hodgson.*

There is no true stauros in this species: a sufficient defining power with accurate illumination shows that the striæ extend over the entire surface of the valve not occupied by the nodules and median line.

40. **Navicula pectinalis,** *Bréb.* F.V. extremities truncate; V. linear-

elliptical, extremities rounded; striæ 22 in ·001″. Length of V. ·0008″ to ·0016″. Breadth of V. ·0002″. v.s.

Bréb. in lit. Oct. 1852, cum specim.

Brackish water. Saltcoats, Feb. 1854, and Powburn, July 1854, *Dr. Arnott.*

41. **Navicula retusa,** *Bréb.* F. V. extremities truncate with rounded angles; V. linear, extremities rounded; striæ 16 in ·001″. Length of V. ·0018″ to ·0022″. Breadth of V. ·0004″. v.v.

Bréb. Diat. Cherb. fig. 6.

Marine. Cork Harbour, Nov. 1855, *W. Sm.*

42. **Navicula Cocconeiformis,** *Greg.* V. elliptical; extremities subacute, or slightly produced and rounded; striæ indistinct, 54 in ·001″. Length of V. ·0008″ to ·0011″. Breadth of V. ·0004″. v.s.

Grev. Ann. 2nd ser. vol. 15. pl. ix. 6. Greg. Mic. Journ. vol. 4. pl. i. 22.

Fresh water. Braemar, August 1854, *Dr. Balfour.*

43. **Navicula elliptica,** *Kütz.*=*N. ovalis,* Synop. xvii. 153.

Var. β. Valve linear, or slightly constricted at centre. v.s.

Fresh water. Lough Leven, June 1855, *Dr. Gregory.*

The insertion of this interesting form affords me an opportunity of rectifying the synonymy of *N. elliptica* and *N. ovalis* of the Synopsis, vol. i. p. 48. M. De Brébisson informs me that *N. elliptica,* Kütz. Bacill. xxx. 55, is a freshwater form, first found by himself at Falaise; that it is identical with my *N. ovalis,* and therefore claims priority over this latter, which must in consequence be superseded. He suggests that the name *N. ovalis* should be cancelled, and that the name *N. Smithii* be given to the marine species, which I had designated *N. elliptica*: I gladly accept the compliment, and shall make the correction in a future revision of the text.

44. **Navicula Amphisbæna.** Synop. xvii. 147.

Var. γ. V. extremities scarcely produced, and subacute. v.v.

Brackish water. Wisbeach, January 1854, *Mr. S. Smith.* Foundations of Cleddan Bridge near Haverfordwest, July 1854, *Mr. Okeden.*

45. **Navicula Rostellum,** *W. Sm.* V. elliptical-oval; extremities produced into distinct rostra; striæ 80 in ·001″. Length of V. ·0015″. Breadth of V. ·0007″. v.v.

Navicula apiculata, Greg. Mic. Jour. vol. 4. pl. i. 13.

Fresh water. Grasmere, August 1853, *W. Sm.* Falls of the Tummel, July 1854, *Dr. Greville.*

The name *N. apiculata* has been appropriated by M. De Brébisson (Diat. Cherb. fig. 5) to a marine species quite distinct from the present.

46. **Navicula Hennedyii,** n. sp. Valve elliptical, subacute, or rostrate at the extremities; marginal band of equal breadth throughout; striæ 24 in ·001″. Length of valve ·0029″ to ·0042″. Breadth of valve ·0016″ to ·0024″. v.v.

Marine. Frith of Clyde, January 1854, *Mr. Hennedy.* Poole Bay, September 1854; Stomach of Pecten, Kinsale Bay, April 1855, *W. Sm.* Lyme Regis, Dorsetshire, 8 fathoms, November 1855, *Mr. Capron.*

47. **Navicula Lyra,** *Ehr.* Valve elliptical, subacute or rostrate; striæ in a marginal and two central bands; marginal band of unequal width; striæ 20 in ·001″. Length of valve ·0036″ to ·0064″. Breadth of valve ·0018″ to ·0026″. v.v.

Ehr. in Kütz. Bacill. xxviii. 55; Sp. Alg. p. 74. *N. elliptica* (*N. Smithii,* Bréb.), sporangial? Synop. pl. xvii. 152 *a**.

Marine. Salt Pans, Hampshire, September 1854, *W. Sm.* Cumbrae, January 1854, *Dr. Arnott.*

The last two species are almost identical in form; but the arrangement of the striæ in each is peculiar, and constant under every shape and size of the individual frustule. In *N. Hennedyii* the marginal striæ form a continuous band of equal width along the circumference of the valve, and the unstriated portion of the surface, between the border and the linear longitudinal bands that lie along the median line, is, in consequence, of unequal width, having the outline of a segment of a circle. The unstriated portion of *N. Lyra* is, on the contrary, almost linear, and the marginal band of striæ has the outline of a segment of a circle slightly inflated at the centre of its base: in both the striæ are beautifully moniliform, though the character is more apparent in the last: both species occur with the extremities sometimes subacute and sometimes rostrate.

48. **Navicula humerosa,** *Bréb.* Valve nearly linear, or slightly

constricted at centre; ends truncate, with a central rostrum; striæ 24 in ·001″. Length of valve ·0024″ to ·0027″. Breadth of valve ·0012″. v.s.

Bréb. in lit. May 1854.

Marine or brackish water. River Nene near Wisbeach, June 1854, *Mr. S. Smith.* Near Saltcoats, July 1854, *Dr. Arnott.*

This approaches *N. granulata*, Bréb. MSS., but has much finer and less conspicuously moniliform striæ.

49. **Navicula Crabro,** *Ehr.* Valve deeply constricted, panduriform; extremities subacute; striæ distinct, obscurely moniliform, nitescent, 10 in ·001″. Length of valve ·0027″ to ·0040″. Breadth of lobes ·0013″; ditto at constriction ·0008″. v.s.

Ehr. in Kütz. Sp. Alg. p. 83. *Diploneis Crabro*, Ehr. Microg. xix. 29. *Navicula Pandura*, Bréb. Diat. Cherb. fig. 4.

Marine. Stomach of Pecten, Coast of Sussex, and Kinsale Bay, Co. Cork, *W. Sm.* Frith of Clyde; Carrickfergus Bay, February 1855, *Mr. Hennedy.*

I do not know the characters upon which Ehrenberg has founded his genus *Diploneis*, but see nothing in this species to warrant its separation from *Navicula*: its close alliance with *N. didyma*, and the moniliform character of its striæ, which, though obscure, is to be detected with careful manipulation, leave no doubt of its position.

50. **Navicula trinodis,** n. sp. Valve with a double constriction, dividing its surface into three nearly equal lobes; extremities rounded; striæ obscure. Length of valve ·0007″ to ·0009″. Breadth of valve at constriction ·00013″. Breadth of valve at lobes ·0002″. v.s.

Fresh water. Bridge of Allan, August 1855, *Dr. Arnott.* Stirlingshire, July 1855, *Dr. Greville.* St. Abb's Head, July 1855, *Dr. Balfour.*

51. **Pinnularia borealis,** *Ehr.* Valve linear-elliptical, sometimes with a slight central constriction; extremities rounded or subtruncate; costæ not reaching median line, 13 in ·001″. Length of V. ·0013″ to ·0025″. Breadth of V. ·0003″ to ·0004″. v.v.

Ehr. in Kütz. Bacill. xxviii. 68 & 72. Raben. Süssw. Diat. vi. 19. Ehr. Microg. passim. Greg. Mic. Journ. vol. iv. p. 2. *Pinnularia late-striata*, Greg. Mic. Journ. vol. 2. pl. iv. 13. *P. Hebridensis*, Greg. Mic. Journ. vol. ii. p. 28.

Fresh water. Grasmere, August 1853; Co. Cork, June 1855, &c., *W. Sm.* Mull Deposit; River Spey; Lough Leven, and Elchies, Bamffshire, *Dr. Gregory*. Haverfordwest, April 1855, *Mr. Okeden*. Near Silverdale, Lancashire, December 1855, *Mr. Johnson*. (Mont Dore, Auvergne, elev. 4000 feet, June 1854, *W. Sm.*)

52. **Pinnularia hemiptera,** *W. Sm.* Valve linear-elliptical, with rounded extremities; costæ radiate, not reaching median line, 27 in ·001″. Length of valve ·0026″ to ·0036″. Breadth of valve ·0004″ to ·0005″. v.v.

Navicula hemiptera, Kütz. Bacill. xxx. 11. ad specim. authen. quæ dedit cl. De Brébisson.

Fresh water. Parham Park and Rackham Common, Sussex, August 1853; Co. Cork, frequent, *W. Sm.* Falls of the Tummel, July 1854, *Dr. Greville.*

A very frequent form in subalpine districts; often overlooked from its resemblance to *P. viridis,* from which it is distinguished by its finer striæ and narrower valve.

53. **Pinnularia gracillima,** *Greg.* Valve linear, constricted towards the rounded extremities; striæ submarginal, often abbreviated towards the centre of valve, 27 in ·001″. Length of valve ·0016″ to ·0028″. Breadth of valve ·0002″. v.v.

Var. β. A larger form with attenuated extremities. v.s.

Greg. Mic. Journ. vol. 4. pl. i. 31. Grev. Ann. ser. 2. vol. xv. p. 5. Var. β. *P. tenuis,* Greg. Mic. Journ. vol. 2. pl. iv. 9.

Fresh water: often with the last species. Fell-end, Lancashire, *Mr. Johnson*. Var. β. Mull Deposit; Braemar, August 1854, *Dr. Balfour.*

The apparent absence of striæ from the centre of the valve, where they often become marginal dots, led me at first to name this species *P. vaciva*; but I am now disposed to regard this character as of little importance. The form *Navicula pisciculus,* Ehr. Kütz. Bacill. xxviii. 64, is perhaps identical with the present.

I cannot specifically distinguish var. β. from the ordinary form.

54. **Pinnularia Polyonca,** *Bréb.* Valve with a central and two smaller intermediate inflations; extremities capitate and rounded; striæ submarginal, 24 in ·001″. Length of valve ·0016″ to ·0031″. Breadth at central inflation ·0003″ to ·0006″. v.s.

Bréb. in Kütz. Sp. Alg. p. 85. ad specimina authentica. *Pinnularia undulata,* Greg. Mic. Journ. vol. 2. pl. iv. 10.

Fresh water. Mull Deposit, *Dr. Gregory.*

55. **Pinnularia nodosa,** *W. Sm.* Valve with three subequal inflations; extremities subcapitate, produced; striæ marginal, 18 in ·001″. Length of valve ·0018″ to ·0025″. Breadth at inflations ·0004″ to ·0005″. v.v.

Navicula nodosa, Ehr. Inf. xiii. 9. Kütz. Bacill. xxviii. 81. Greg. Mic. Journ. vol. 4. pl. i. 5.

Fresh water. Elchies, Bamffshire, August 1854, *Prof. Kelland.* (Puy-du Capucin, Mont Dore, elev. 4567 feet, June 1855, *W. Sm.*)

56. **Pinnularia interrupta.** Synop. xix. 184.

Var. β. Costæ not interrupted. v.v.

Pinnularia biceps, Greg. Mic. Journ. vol. 4. pl. i. 28.

Fresh water. New Forest, Hampshire, September 1854; Co. Cork, frequent, &c., *W. Sm.* Fell-end, Lancashire, August 1854, *Mr. Johnson.* Haverfordwest, July 1855, *Mr. Okeden.*

The absence or presence of the costæ at the centre of the valve appears to be an accidental circumstance, as numerous frustules may be found in which the interruption is more or less complete. I cannot therefore at present admit Dr. Gregory's new species *P. biceps,* the specific name of which is still further inadmissible, having been appropriated to a very different form, viz. *Navicula biceps,* Ehr.

57. **Pinnularia integra,** *W. Sm.* Valve elliptical-lanceolate, with a slight subterminal constriction and linear produced apices; striæ indistinct, 36 in ·001″. Length of valve ·0008″. Greatest breadth of valve ·0004″. v.s.

Pinnularia rostrata, Greg. Mic. Journ. vol. 4. pl. i. 14.

Fresh water. Powmouth, Ayrshire, July 1854, *Dr. Arnott.*

Owing apparently to a central and transverse inflation of the frustule, the striæ are more distinct and distant at the middle portion of the valve.

The necessity of avoiding confusion in the synonymy of genera so closely allied as *Navicula* and *Pinnularia,* and the appropriation of the specific name *rostrata* to *Navicula rostrata,* Ehr. in Kütz. Bacill. iii. 55, necessitate the rejection of an appellation otherwise appropriate and descriptive. The term *integra* is designed to imply, that the appearance of a stauros, when the ends of the valve are *out* of focus, is deceptive, and that the striæ are truly continuous over the entire length of the valve.

58. **Pleurosigma transversale,** *W. Sm.* Valve on S. V. elliptical-lanceolate; extremities obtuse, occasionally slightly produced;

striæ 45 in ·001″. Length of valve ·0032″ to ·0044″. Breadth of valve ·0006″ to ·0007″. v.v.

Gyrosigma transversale, Micrographic Dictionary, May 1854, pl. xi. 37, 38.
Pleurosigma Naviculaceum, Bréb. Diat. Cherb. fig. 7.

Marine. Stomach of Pecten, Coast of Sussex, February 1853 and March 1854; Kinsale Harbour, April 1855, &c., *W. Sm.* Stomach of Mytilus, Coast of Devonshire, *Mr. D'Alguen*, March 1854; Plymouth, January 1854, *Dr. Arnott*. Thames mud, March 1854, *Mr. Roper*. Milford Haven, April 1854, *Mr. Okeden*. Lyme Regis, Dorsetshire, 8 fathoms, November 1855, *Mr. Capron*.

The present species affects deep water, and seems plentifully diffused along the British coasts. Its outline is that of a *Navicula*; but no one familiar with these organisms will hesitate to place it with the sigmoid forms of the *Pleurosigmata*, to which the position of its median line and the structure of its valve manifestly ally it.

The alliterative blunder in the name *Gyrosigma* must be my excuse for not adopting it as the designation of this division of the *Naviculaceæ*, an excuse whose validity I find thus admitted by M. De Brébisson in the brochure above quoted :—"*Gyrosigma*, Hassall. Peut-être ce dernier nom de genre n'était-il pas bien convenable selon les lois de la nomenclature ; dans tous les cas, il est certain que, malgré son droit de priorité, il est à peu près généralement abandonné, comme cela arrive promptement pour les puissances déchues. D'ailleurs, on est d'autant moins disposé à reprocher ce changement de nom à M. W. Smith, que le soin tout monographique qu'il a apporté à l'étude des nombreuses espèces de *Pleurosigma* qu'il a découvertes, en fait un genre tout à lui."

59. **Synedra undulata,** *Bail.* F. V. linear-truncate, arcuate; V. linear-arcuate, inflated at the centre and towards the rounded extremities; margins undulated; nodule obsolete; striæ moniliform, 24 in ·001″. Length of F. ·0134″ to ·0166″. Breadth of V. at centre ·00033″; at extremities ·00025″; at the intermediate points ·00017″. v.v.

Bail. MSS. et specim. *Synedra undulans*, Greg. Mic. Journ. vol. 3. pl. iv. 23.
Toxarium undulatum, Bail. Mic. Organ. figs. 24, 25.

Marine. Cork Harbour: attached to *Polysiphonia nigrescens*, dredged in depth of 5 fathoms, July and October 1855, *W. Sm.* Near Lyme Regis, Dorsetshire, in 8 fathoms, November 1855, *Mr. Capron*.

This beautiful and curious species was first determined as British by Dr. Gregory, who found portions of its valves in a sandy deposit from the valley of Glenshira near Inverary, and subsequently a single fragment of a valve in a gathering I made in Poole Bay in 1849. The specimens I afterwards col-

lected in Cork Harbour were in a living state and in great abundance, and from their length formed a conspicuous object even to the unassisted eye.

Specimens sent me by M. De Brébisson are still larger than our native forms. I have measured frustules from Brest ·0318″ in length, or nearly twice as long as the Cork specimens.

Professor Bailey has, as will be seen, constituted a new genus for the reception of this species; but I think its general characters are sufficiently near those of *Synedra* to permit its retention in that genus.

60. **Synedra deformis,** n. sp. Frustules direct; nodule obsolete; valve linear or linear-elliptical, suddenly constricted towards the produced and often distorted extremities; striæ 36 in ·001″. Length ·0005″ to ·0008″. Breadth of valve ·0002″. v.v.

Fresh water. Lewes, Sussex, March 1853, *W. Sm.*

61. **Synedra investiens,** n. sp. Frustules direct; nodule obsolete; valve linear, slightly attenuated towards the rounded extremities; striæ 26 in ·001″. Length of F. ·0005″ to ·0012″. Breadth of V. ·00014″. v.v.

Marine: thickly covering an *Ectocarpus*. Kirkaldy, Fifeshire, March 1854, *Dr. Greville.*

62. **Synedra tenera,** n. sp. Frustules direct, clustered; V. nearly linear, or attenuated towards the slightly inflated extremities; nodule indefinite; striæ 60 in ·001″. Length of F. ·0022″ to ·0066″. Breadth of V. ·00005″ to ·0002″. v.v.

Fresh water. Saltcoats, January 1854, *Dr. Arnott.* New Forest, September 1854; Lough Alloa, Co. Cork, June 1855; near Blarney and near Killaloe, Co. Cork, July 1855, *W. Sm.*

In outline not unlike *S. delicatissima,* with which it often occurs intermixed, but it is a far smaller form and with more delicate striæ.

63. **Gomphonema Naviculoides,** n. sp. Stipes quite distinct and regularly dichotomous; F. V. nearly linear, truncate; valves lanceolate, acute; nodule central; extremities equal; striæ 30 in ·001″. Length ·0013″ to ·0025″. v.v.

Fresh water. Tank of *Victoria Regia,* Botanical Garden, Edinburgh, August 1853, *Dr. Greville.*

The valve of this interesting species is not to be distinguished from that of

a *Navicula*, the nodule being almost exactly central. The species has not occurred to any other collector, and may probably be of foreign origin.

64. **Gomphonema capitatum,** *Ehr.* Synop. p. 80.

Var. β. Upper portion of valve almost linear, elongated, equal to, or slightly exceeding the lower. v.v.

Var. γ. V. much attenuated towards both extremities. v.v.

Var. β. W. Sm. Ann. ser. 2. vol. 15. pl. i. 2β. Var. γ. W. Sm. *l. c.* fig. 2γ. *Gomphonema Fusticulus*, W. Sm. MSS. Greg. Mic. Journ. vol. iii. p. 37.

Fresh water. Var. β. Itford near Lewes, November 1853; Grasmere, August 1853, *W. Sm.* River Spey, July 1854, *Dr. Gregory*. Var. γ. Braemar, August 1854, *Dr. Balfour*. (Var. β. Puy du Cliergue, Auvergne, elev. 5576 feet. Var. γ. Near Marseilles, May 1854, *W. Sm.*)

65. **Gomphonema ventricosum,** *Greg.* V. inflated at the centre, linear, and rounded towards the upper, constricted and obtuse towards the lower extremity; striæ 30 in ·001″. Length of F. ·0013″ to ·0018″. v.s.

Greg. Mic. Journ. vol. 4. pl. i. 40.

Fresh water. River Spey, July 1854, *Dr. Gregory*.

66. **Gomphonema elongatum,** *W. Sm.* V. inflated at centre, with a submedian constriction in both divisions; the upper extremity capitate, apiculate, or cuneate; the lower slightly inflated below the constriction and obtuse; striæ 24 in ·001″. Length of F. ·0018″ to ·0045″. v.v.

W. Sm. Ann. ser. 2. vol. 15. pl. i. 4. *G. Brebissonii?* Greg. Mic. Journ. vol. 2. pl. iv. 18.

Fresh water. Near Wisbeach, April 1854, *Mr. S. Smith*; Barley Lake, Co. Cork, June 1855, *W. Sm.* Mull Deposit, *Dr. Gregory*. (Puy du Cliergue, Auvergne, June 1854, *W. Sm.*)

67. **Gomphonema rostratum,** n. sp. Stipes distinct; V. ovate-elliptical, produced at the upper extremity into a linear, obtuse rostrum; slightly constricted near the lower extremity; striæ 30 in ·001″. Length of F. ·0009″ to ·0012″. Greatest breadth of V. ·00025″. v.v.

Fresh water. Barley Lake, Co. Cork, elev. 780 feet, June 1855, *W. Sm.*

68. **Gomphonema Sarcophagus,** *Greg.* V. linear-ovate, abruptly

constricted near both extremities; the upper slightly produced, linear and truncate; the lower somewhat capitate and obtuse; striæ 20 in ·001″. Length ·0012″ to ·0017″. Greatest breadth of V. ·0003″. v.s.

Greg. Mic. Journ. vol. 4. pl. i. 42.

Fresh water. Lough Leven, September 1854, *Dr. Gregory.*

69. **Gomphonema insigne,** *Greg.* V. lanceolate, upper extremity rounded, lower subacute; striæ 20 in ·001″. Length of F. ·0016″ to ·0025″. Greatest breadth of V. ·0005″. v.s.

Greg. Mic. Journ. vol. 4. pl. i. 39.

Fresh water. Duddingston Lough near Edinburgh, April 1854, *Dr. Greville.* Braemar, August 1854, *Dr. Balfour.*

The last two species are probably varieties of the same form.

70. **Gomphonema Fibula,** *Bréb.* F. V. slightly cuneate; V. sublinear, constricted near the upper and larger extremity, which is conspicuously capitate, obtuse at the lower; stipes abbreviated; nodule obsolete; striæ 40 in ·001″. Length of F. ·0016″ to ·0024″. Greatest breadth of V. ·00025″. v.v.

Bréb. in Kütz. Sp. Alg. p. 65. ad specim. authen.

Fresh water. Rackham Common, Sussex, August 1853, *W. Sm.* (Falaise, *M. De Brébisson.*)

The absence of a nodule and the abbreviated stipes would rather point to *Synedra* as the genus of this form; but the cuneate frustule is precisely that of a *Gomphonema.*

71. **Gomphonema subtile,** *Ehr.* Valve slightly inflated at centre, gradually attenuated towards both extremities, the upper of which is capitate and truncate, and the lower obtuse; striæ 26 in ·001″. Length of F. ·0018″. v.v.

Ehr. in Kütz. Sp. Alg. p. 68. Microg. xvi. iii. 38, &c. Greg. Mic. Journ. vol. 4. pl. i. 12.

Fresh water. Lough Avaul, Co. Cork, June 1855, *W. Sm.*

Doubtfully distinct from *G. constrictum* or *G. acuminatum.* First detected as a British form by Dr. Gregory of Edinburgh, and said by him to occur in two localities in Scotland.

PODOCYSTIS, *Bail.* Nov. Gen.

Frustules attached, sessile, cuneate; valves convex, obovate, striated; with a median line and transverse costæ.

The transverse costæ or canaliculi distinguish this genus from *Podosphenia*; its attached growth and moniliform striæ from *Surirella*.

72. **Podocystis Americana,** *Bail.* Striæ moniliform, 30 in ·001″; costæ 12 in ·001″. Length of F. ·0016″ to ·0026″. Greatest breadth of V. ·0011″. v.v.

Bail. Mic. Org. fig. 38. *Doryphora elegans,* Roper, Mic. Journ. vol. ii. p. 284.

Marine. In the mud of Pembroke Harbour, August 1854, *Mr. Roper.* (New York, on *Grinnellia Americana*; communicated by *Dr. Arnott.* Near Marseilles, May 1854, *W. Sm.*)

B.

The following list includes those British forms described or figured by other writers, which are either unknown to me, imperfectly known, or appear to belong to species included in Vol. I. of the present Work :—

Epithemia gibberula, Ehr., Greg. Mic. Journ. vol. 2. pl. iv. 2.

Eunotia incisa, Greg. Mic. Journ. vol. 2. pl. iv. 4. v.s.

This appears to be a new species; but, not having seen it in a fresh state, I am unable with certainty to determine either its generic or specific characters. It will probably be found to be a *Himantidium.* Its valves are arcuate, rounded or subacute at their extremities, with subterminal notches or depressions on their concave margins; striæ 44 in ·001″. Length ·0016″ to ·0022″.

Eunotia Falx, Greg. Mic. Trans. vol. ii. p. 105; Mic. Journ. vol. 3. pl. iv. 1 = *Synedra Hemicyclus,* Ehr. in Kütz. Sp. Alg. p. 48. Ehr. Microg. pl. xvi. i. 38 & xvi. ii. 47.

Cymbella truncata, Greg. Mic. Journ. vol. 3. pl. iv. 3 = *C. affinis,* W. Sm. Synopsis, pl. xxx. 250. v.s.

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Cymbella turgida, Greg. Mic. Journ. vol. 4. pl. i. fig. 18.
„ **obtusa,** Greg. *l. c.* fig. 19.
„ **Pisciculus,** Greg. *l. c.* fig. 20.
„ **sinuata,** Greg. *l. c.* fig. 17.
„ **hyalina,** Ag., Grev. B. F. p. 414. Not Diatomaceous.
„ **minor,** Ag. in Grev. B. F. = *Cocconema Cistula.*
„ **cymbiformis,** Ag. } Grev. B. F. p. 414.
„ **reniformis,** Ag. }

Amphora Arcus, Greg. **A. incisa,** Greg. **A. angularis,** Greg. Mic. Journ. vol. 3. pl. iv. figs. 4, 5 & 6 = *Amphora ovalis,* W. Sm.?

Cocconeis transversalis, Greg. **C. speciosa,** Greg. **C. distans,** Greg. **C. costata,** Greg. Mic. Journ. vol. 3. pl. iv. figs. 7, 8, 9 & 10 = *Cocconeis Scutellum,* W. Sm.?

Eupodiscus Ralfsii ? *β,* Greg. Mic. Journ. vol. 3. pl. iv. fig. 11.

Triceratium membranaceum, Brightwell. "Walls of the frustule extremely delicate; sides convex; angles attenuated, ending in minute papillæ; frustule dotted over with very minute cells. Diam. 1–233^{d}." Marine. "Thames mud," Bright. Mic. Journ. vol. 1. p. 251. pl. iv. 15.

Triceratium obtusum, Ehr. "Thames mud," Bright. *l. c.* fig. 20.
„ **comptum,** Ehr., Bright. *l. c.* p. 249 & fig. 4. Roper, Mic. Journ. vol. 2. p. 283 = *T. Favus,* Synop. pl. v. 44?

Surirella Jennerii, Hass. Alg. p. 439. pl. cii. 15 = *S. bifrons,* Synop. pl. viii. 57?

Surirella fastuosa *β,* Greg. Mic. Journ. vol. 3. pl. iv. 12 = *S. fastuosa,* Synop. pl. ix. 66?

Surirella tenera, Greg. Mic. Journ. vol. 4. pl. i. 38 = *S. linearis,* Synop. viii. 58?

Amphiprora vitrea *β,* Greg. Mic. Journ. vol. 3. pl. iv. 14 = *A. elegans,* W. Sm.?

Navicula Palea, Hass. Alg. p. 430. pl. cii. 10.
„ **Platystoma,** Ehr., Hass. Alg. p. 431. pl. cii. 6.
„ **birostrata,** *Greg. Mic. Journ. vol. 3. pl. iv. 15.*
„ **rhombica,** *Greg. l. c. fig. 16.*
„ **gastroides,** Greg. *l. c.* fig. 17 = *N. pusilla,* Synop. xvii. 145.
„ **crassa,** Greg. *l. c.* fig. 18.
„ **maxima,** Greg. *l. c.* fig. 19.
„ **Trochus,** Ehr., Greg. Mic. Journ. vol. 4. pl. i. 2.

Navicula dubia, Kütz., Greg. *l. c.* fig. 3.
„ **Bacillum,** Ehr., Greg. *l. c.* fig. 4.
„ **lacustris,** Greg. Mic. Journ. vol. 4. pl. i. fig. 23.
„ **lepida,** Greg. *l. c.* fig. 25.
„ **incurva,** Greg. *l. c.* fig. 26.
„ **longiceps,** Greg. *l. c.* fig. 27.

Pinnularia varians, Greg. **P. mutabilis,** Greg. Mic. Trans. vol. iii. p. 10. pl. ii. figs. 1–33.

In the paper quoted, Dr. Gregory figures and describes a number of forms under the above names, which vary greatly in the outline and size of their valves, but are all referred by him to two typical modes of striation, viz. *Pinnularia varians*, with 14 to 18 striæ in ·001″, and *P. mutabilis*, with 24 to 26 striæ in ·001″. In his remarks on these species, Dr. Gregory seems disposed to consider that form and size are not to be regarded as of specific importance, justly observing, "that the more the Diatomaceæ are studied, the more do we perceive that in many species the shape or outline is subject to endless variations."

In the absence of any specific descriptions of *P. varians* and *P. mutabilis*, I must therefore conclude that the characters Dr. Gregory attributes to these species are to be sought for in the striation only; and as these correspond to those given in the Synopsis to *Navicula Semen*, *N. tumida*, *Pinnularia oblonga*, *P. peregrina*, *P. acuta*, *P. radiosa*, &c., I feel obliged to conclude, that all the forms included under *P. varians* and *P. mutabilis* may be referred to one or other of the species I have just mentioned.

Pinnularia exigua, Greg. Mic. Journ. vol. 2. pl. iv. 14=*P. mutabilis*, Greg. Mic. Trans. vol. 3. pl. ii. 18 *b*.

Pinnularia parva, Greg. *l. c.* fig. 11.
„ **apiculata,** Greg. Mic. Journ. vol. 3. pl. iv. 21.
„ **Gastrum,** Ehr., Greg. Mic. Journ. vol. 3. pl. iv. 20.
„ **megaloptera,** Ehr., Greg. Mic. Journ. vol. 4. pl. i. 6= *P. lata*, Synop. xviii. 167?

Pinnularia Dactylus, Ehr., Greg. Mic. Journ. vol. 4. pl. i. 7=*P. viridis*, Synop. xviii. 163?

Pinnularia pygmæa, Ehr., Greg. Mic. Journ. *l. c.* fig. 8.
„ **linearis,** Greg. *l. c.* fig. 29.
„ **digito-radiata,** Greg. *l. c.* fig. 32.
„ **subcapitata,** Greg. *l. c.* fig. 30.
„ **Elgensis,** Greg. *l. c.* fig. 33.
„ **globiceps,** Greg. *l. c.* fig. 34.

Stauroneis obliqua, Greg. Mic. Journ. vol. 4. pl. i. 35.
„ **ovalis**, Greg. *l. c.* fig. 36.
„ **dubia**, Greg. *l. c.* fig. 37.
„ **Legumen**, Kütz., Greg. *l. c.* fig. 9.
„ **ventricosa**, Kütz., Greg. *l. c.* fig. 10.

Synedra Vertebra, Greg. Mic. Journ. vol. 3. pl. iv. 22 = *S. pulchella*, Synop. xi. 84?

Cocconema cornutum, Ehr., Greg. Mic. Journ. vol. 4. pl. i. 11 = *C. lanceolatum*, Synop. xxiii. 219?

Cocconema ventricosa? Hass. Alg. p. 427. pl. ci. 4.

Raphoneis gemmifera, Ehr. **R. fasciolata**, Ehr. **R. pretiosa**, Ehr. **R. Rhombus**, Ehr. "Thames mud," Roper, Mic. Trans. vol. 2. pl. vi. figs. 7, 8, 9, 10: all = *Doryphora Amphiceros*, Kütz. Synop. pl. xxiv. fig. 224.

Zygoceros Surirella, Ehr. "Thames mud," Roper, *l.c.* figs. 11, 12.

Gomphonema Hebridense, Greg. "Mull Deposit," Greg. Mic. Journ. vol. 2. pl. iv. 19.

Gomphonema æquale, Greg. Mic. Journ. vol. 4. pl. i. 41 = *G. tenellum*, Synop. xxix. 243.

Podosphenia? oculata, Hass. Alg. p. 425. pl. c. 9 = *Surirella ovata*? Synop. ix. 70.

Licmophora Jurgensii, Ag., Grev. B.F. p. 408 = *Rhipidophora elongata*, young? Synop. xxv. 232.

Melosira Thompsonii, Harv. Man. p. 195: not Diatomaceos?
„ **lineata**, Ag. Grev. B. F. p. 402.
„ **lentigera**, Harv. Man. p. 196: not Diatomaceous?

Fragilaria Carmichaelii, Harv. Man. p. 198.

Frustulia fasciata, Ag.
„ **Ulna**, Ag. } Harv. Man. p. 204.

Styllaria bidentata, Ag.
„ **minutissima**, Ag. } Harv. Man. p. 205.

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Total number of British Species described in the present Work 455.

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MICROSCOPIC PREPARATIONS OF THE DIATOMACEÆ.

Smith and Beck supply the following Diatomaceæ described in the Synopsis. As each specimen has been examined by the Author of that Work, and the Localities marked upon each, the authority of these mountings may be relied upon by those desirous of identifying these interesting and beautiful objects.

A few Foreign specimens of rarer British Forms have been introduced, and are denoted by italics.

The style of the mountings is denoted by the letters affixed. B = balsam, D = dry, and F = fluid.

Diatomaceous Earths, in Balsam.

Peterhead Deposit.
Premnay Peat.
Dolgelly Earth.
Cantyre Peat.
Lough Mourne Deposit.
Lough Island Reavey Deposit.
Mull Deposit.
Newbie Deposit.
Raasay Earth.

DIATOMACEÆ.—VOL. I.

B. Epithemia turgida.
B. Epithemia granulata.
B. Epithemia Zebra.
B. Epithemia Argus.
B. Epithemia longicornis.
B. Epithemia alpestris.
B. Epithemia proboscidea.
B. Epithemia Sorex.
B. Epithemia Musculus.
B. Epithemia Westermanii.
B. Epithemia rupestris.
B. Epithemia constricta.
B. Epithemia gibba.
B. Epithemia ventricosa.
B. Eunotia Arcus.
B. Eunotia gracilis.
B. Eunotia triodon.
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B. Cymbella cuspidata.
B. Cymbella affinis.
B. Cymbella maculata.
B. Cymbella Helvetica.
B. Cymbella Scotica.
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B. Amphora affinis.
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D. Amphora tenera.
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B. Cocconeis Placentula.
B. Cocconeis Thwaitesii.
B. Cocconeis Scutellum.
B. Cocconeis Grevillii.

B. Cocconeis diaphana.
B. Coscinodiscus radiatus.
B. Coscinodiscus eccentricus.
B. Eupodiscus crassus.
B. *Arachnoidiscus Ehrenbergii.*
B. Cyclotella Kützingiana.
B. Cyclotella Rotula.
B. Cyclotella operculata.
B. Campylodiscus costatus.
B. Campylodiscus Ralfsii.
B. Campylodiscus spiralis.
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B. Surirella constricta.
B. Surirella lata.
B. Surirella striatula.
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B. Nitzschia linearis.
B. Nitzschia lanceolata.
B. Nitzschia Amphioxys.
B. Nitzschia vivax.
B. Nitzschia dubia.
B. Nitzschia bilobata.
B. Nitzschia plana.
D. Nitzschia Closterium.
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B. Amphipleura pellucida.
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B. Pinnularia acuta.
B. Pinnularia radiosa.
B. Pinnularia viridula.
B. Pinnularia Cyprinus.
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D. Pleurosigma delicatulum.
B. D. Pleurosigma strigosum.
D. Pleurosigma angulatum.
D. Pleurosigma Æstuarii.
D. Pleurosigma Balticum.
B. Pleurosigma Strigilis.
D. Pleurosigma acuminatum.
D. Pleurosigma distortum.
D. Pleurosigma Fasciola.
D. Pleurosigma macrum.
D. Pleurosigma prolongatum.

D. Pleurosigma littorale.
B. Pleurosigma Hippocampus.
B. Pleurosigma attenuatum.
D. Pleurosigma lacustre.
D. Pleurosigma Spencerii.
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B. Synedra pulchella.
B. Synedra gracilis.
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F. *Licmophora splendida.*

DIATOMACEÆ.—VOL. II.

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B. Achnanthidium coarctatum.
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B. Grammatophora serpentina.
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B. Tabellaria fenestrata.
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B. Podosira hormoides.
B. Podosira maculata.
B. F. Melosira nummuloides.
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DIATOMACEÆ.—APPENDIX.

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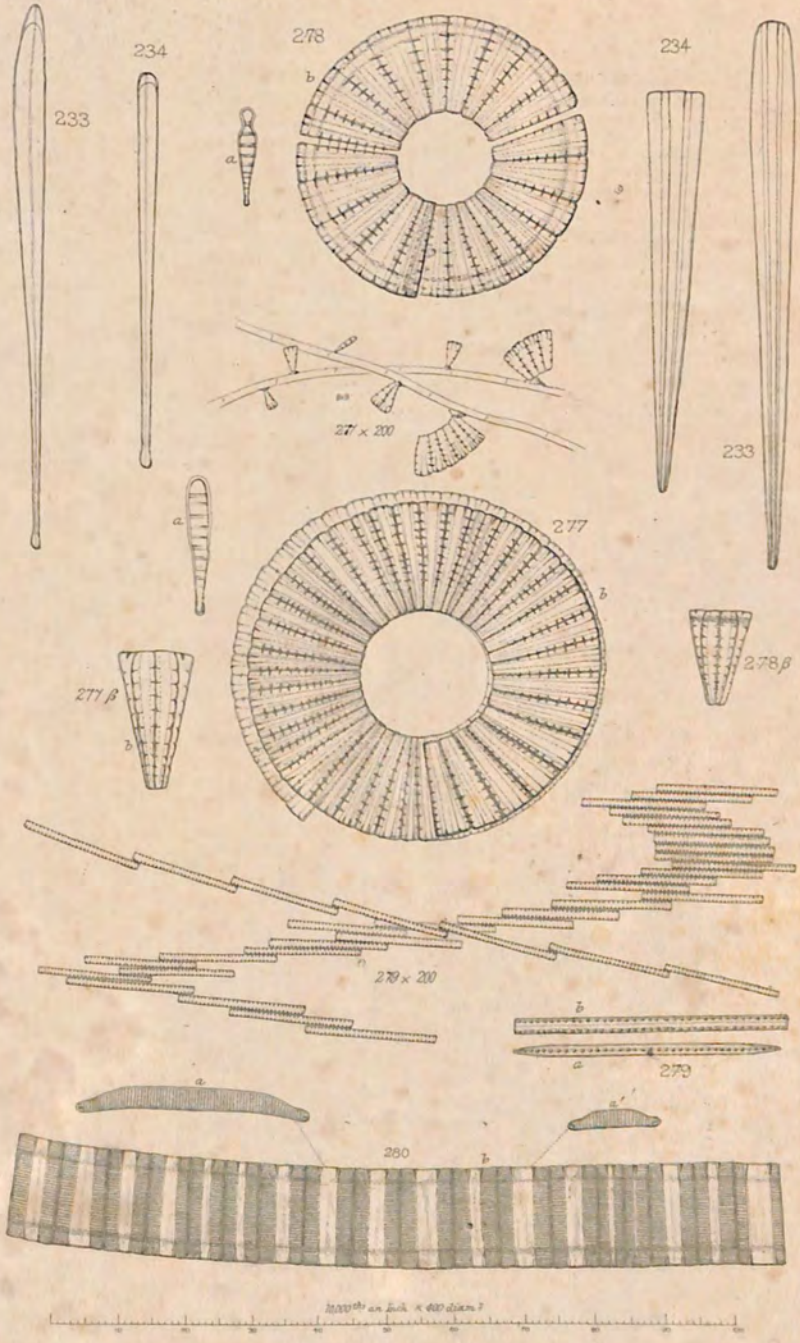
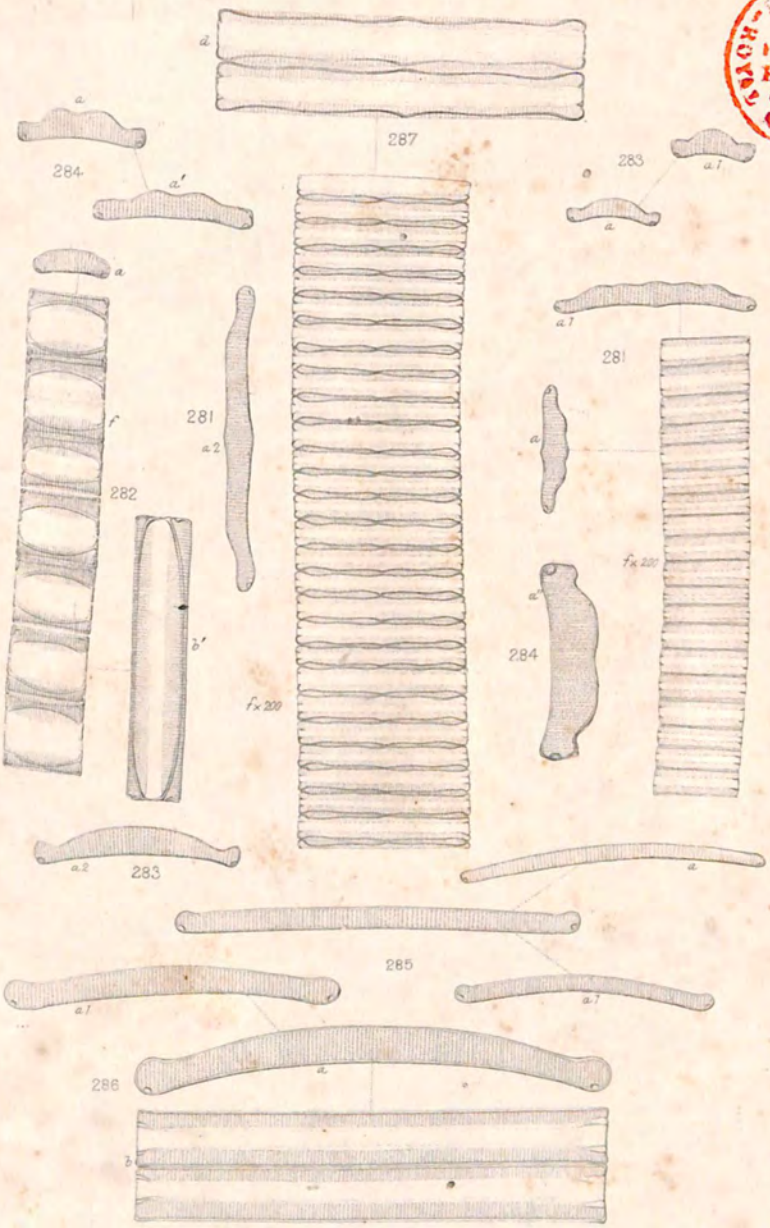
B. Cymbella ventricosa.
B. Cymbella Helvetica β.
B. Cymbella Scotica β.
B. Cymbella lunata.
B. Cymbella æqualis.
B. Eupodiscus Ralfsii.
B. Triceratium exiguum.
B. Cyclotella punctata.
B. Campylodiscus Clypeus.
B. Surirella apiculata.
B. Surirella Amphioxys.
B. Surirella Crumena.
B. Tryblionella levidensis.
B. Nitzschia linearis β.
B. Nitzschia curvula.
B. Navicula scutelloides.
B. Navicula pygmæa.
B. Navicula lævissima.
B. Navicula Lyra.
B. Navicula Amphisbæna γ.
B. Pinnularia borealis.
B. Pinnularia hemiptera.
B. Pinnularia interrupta β.
B. Pleurosigma transversale.
B. Synedra undulata.
B. Synedra deformis.
B. Synedra investiens.
B. Synedra tenera.
B. Gomphonema Naviculoides.
B. Gomphonema capitatum β.
B. Gomphonema elongatum.
B. Gomphonema rostratum.
B. Gomphonema Fibula.



233 *L. splendens* 234 *L. flabellata* 277 *M. circulare*
278 *M. constrictum* 279 *B. paradoxa* 280 *H. pectinale*

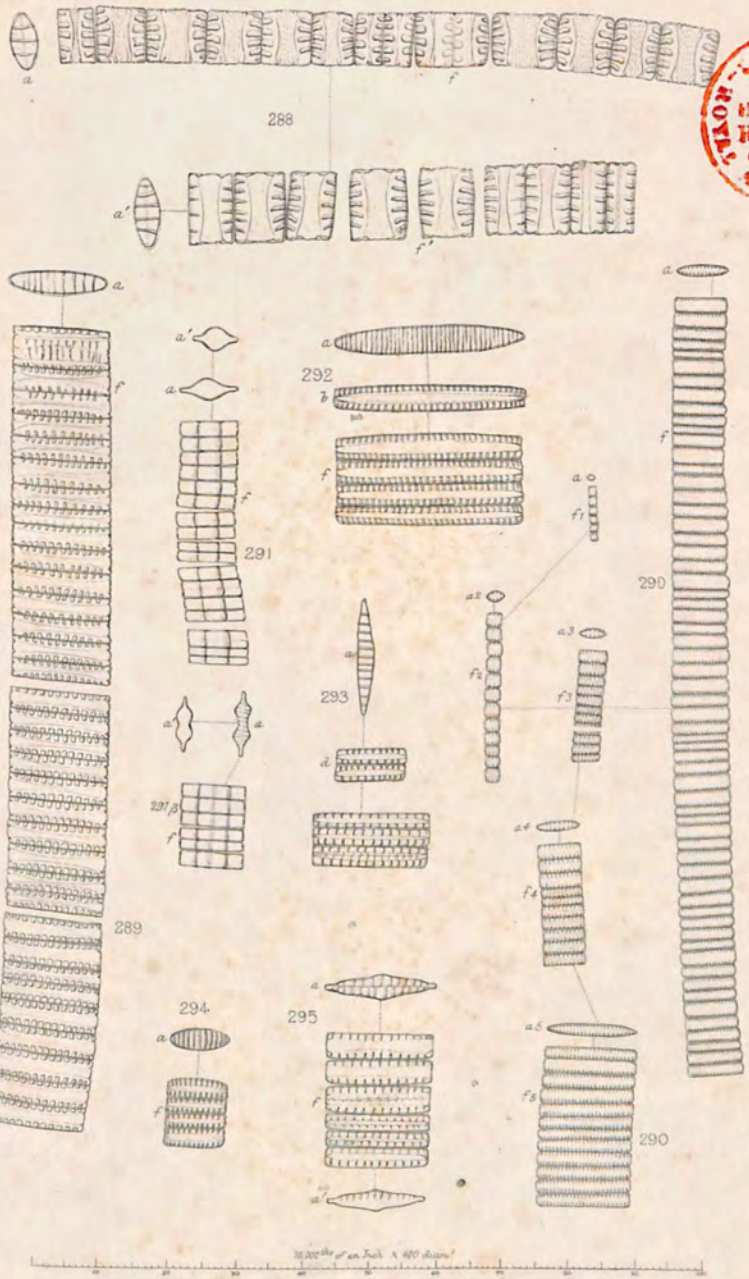
Dillon, West, sculp. et lith.

Bird & Ware, Imp. London.



287 H. undulatum. 282 H. Solanderi. 283 H. Arcus 284 H. bidens.
285 H. gracile. 286 H. majus 287 H. Williamsonii.

ROYAL HORTICULTURAL SOCIETY OF BOMBAY BRANCH OF THE ASIATIC

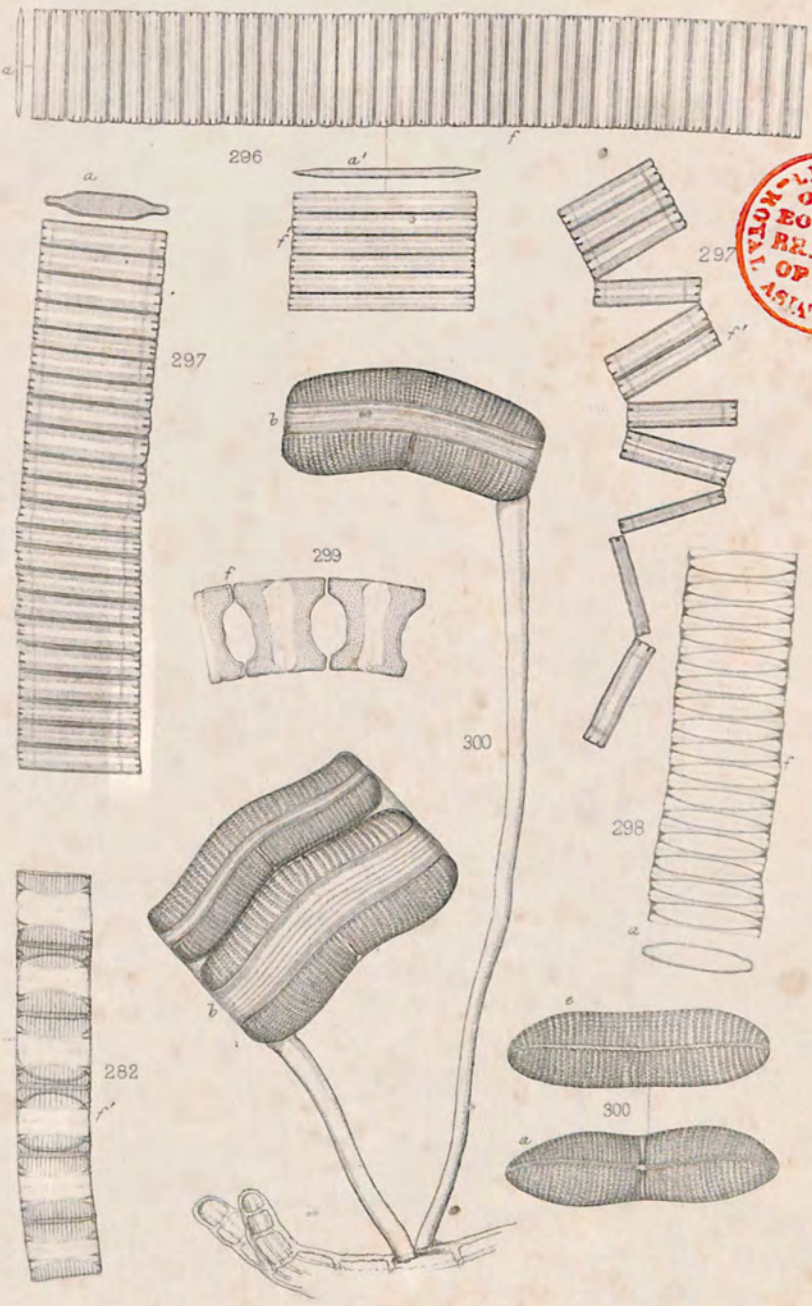


LIBRARY OF THE BOMBAY BRANCH OF THE

288 O mesodon. 289 O hyemale. 290 O mutabile. 291 O Tabellaria.
292 D obtusa. 293 D tenuis 294 D inflata. 295 D sinuata.

Tuffen West, sculp. ad. aut.

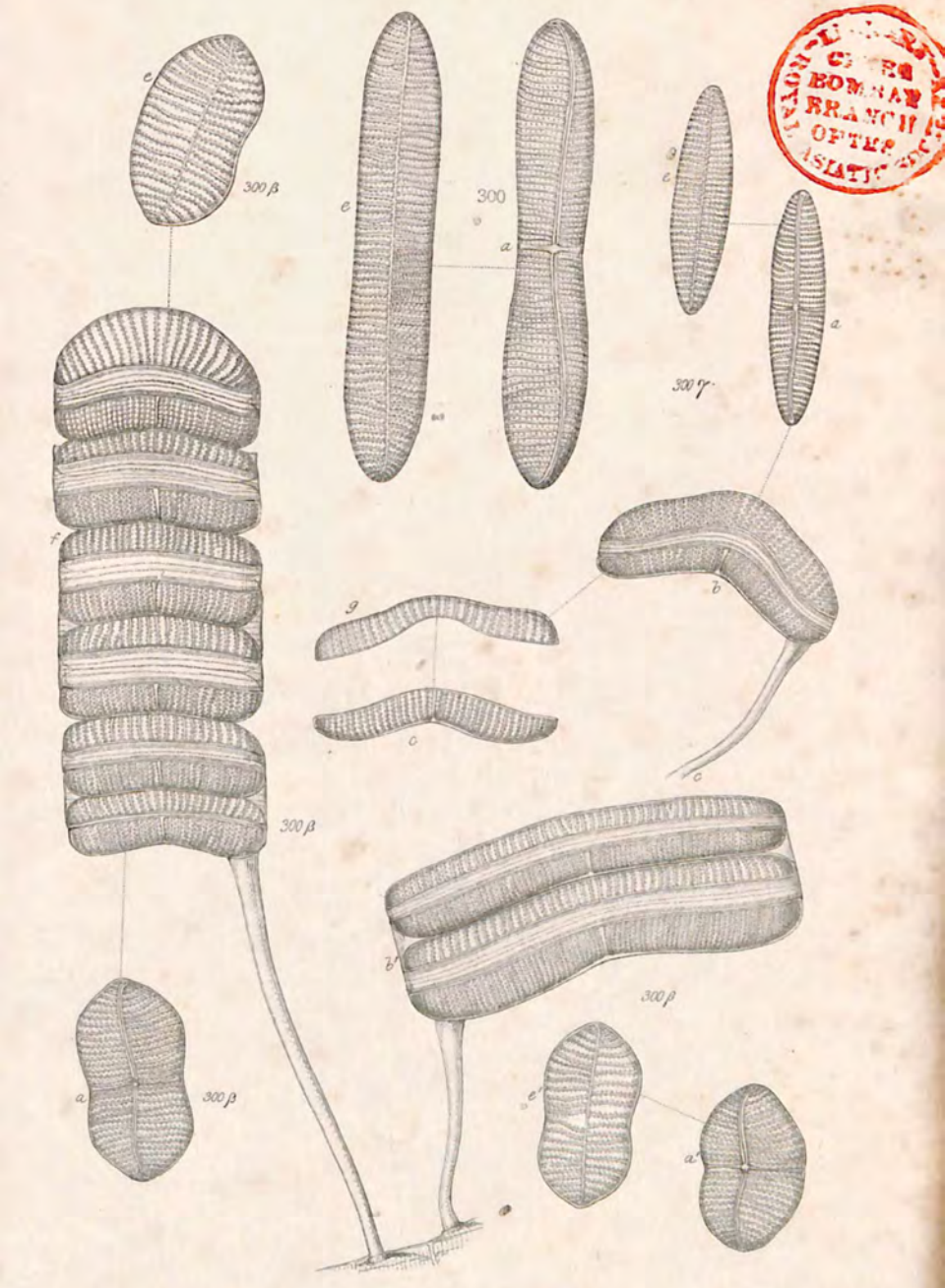
Reed & West, Imp. 94, Eaton Co. Inn.



LIBRARY OF THE BOMBAY BRANCH OF THE ASIATIC SOCIETY

296. F capucina. 297 F virescens. 298 F striatula
299 E Zodiacus. 300 A. longipes. 282 H. Solerdii

Tuffen West sculp. ad nat. Frost & West, lith. London.



300. A. longipes, α, β, & γ.

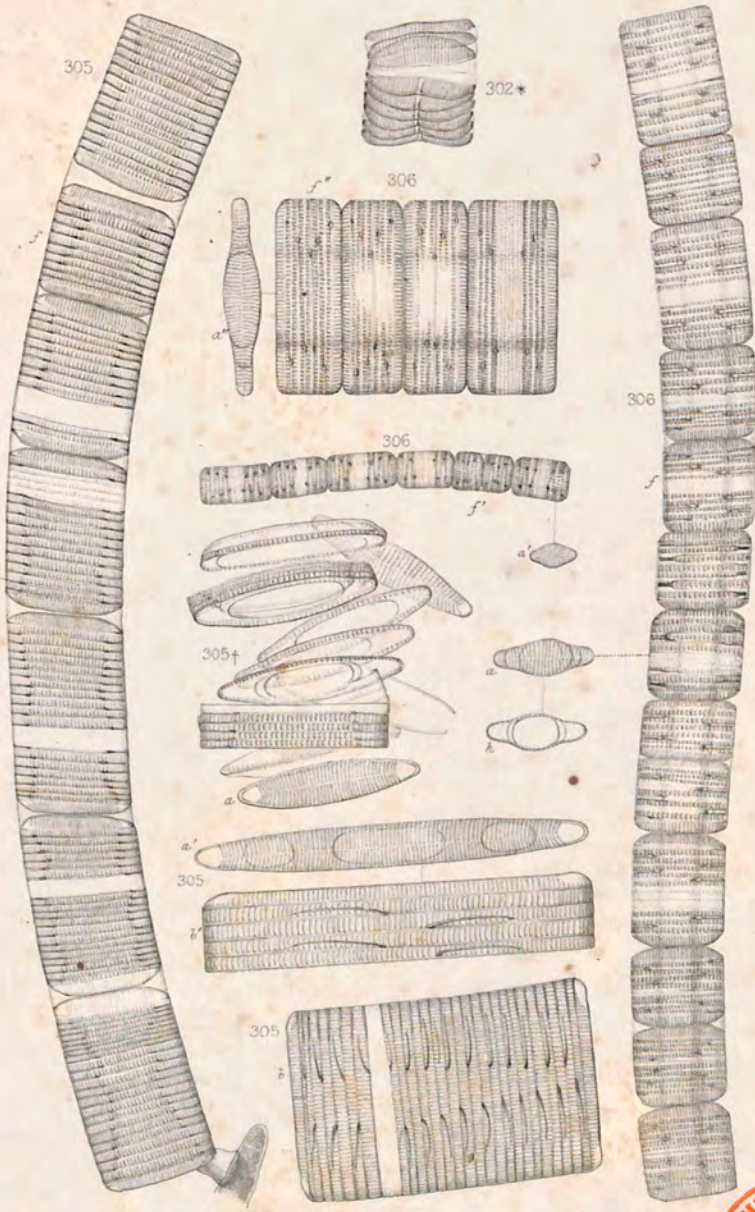
Tuffen West, sculp. et exc.

Lovell & West, Imp. 54, Pleasant Garden.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

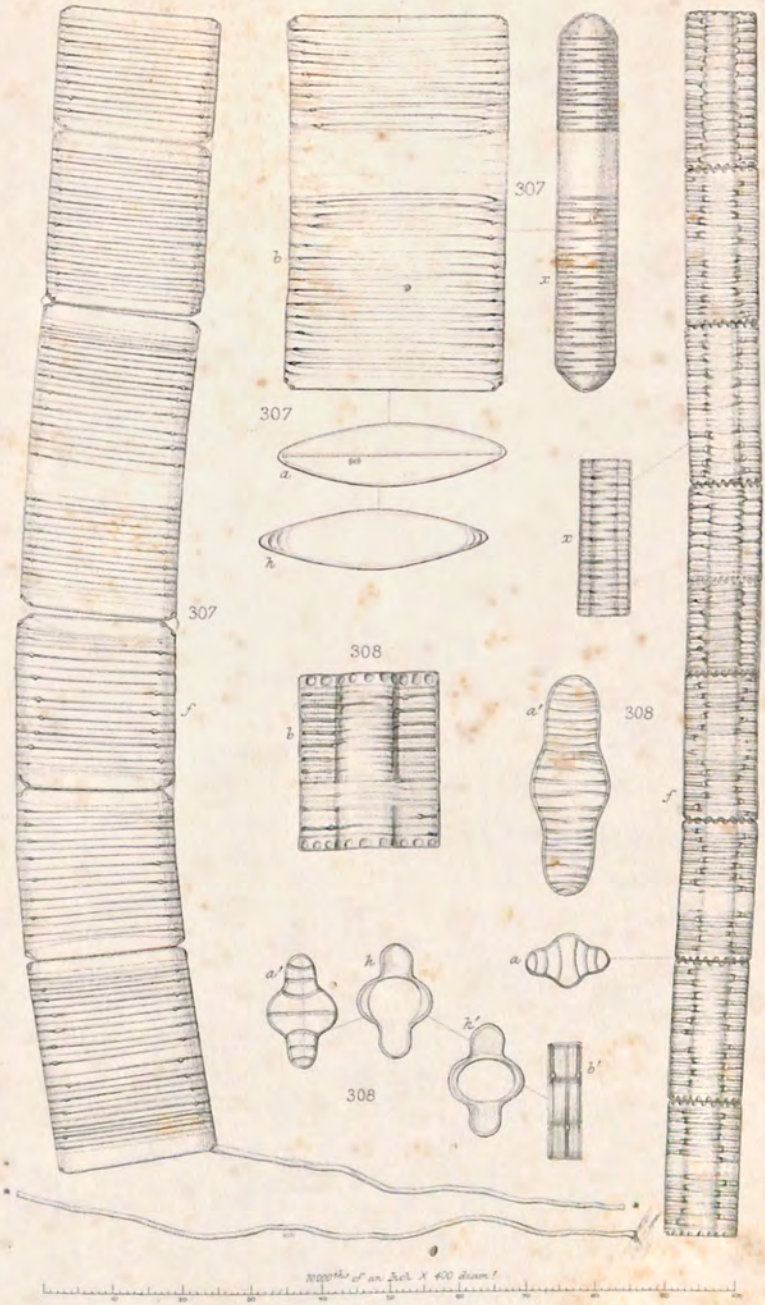
301. *A brevipes* & β. 302. *A subsessilis* 303. *A exilis* & β. 304. *A^m lanceolatum*.

Tuffen West sculp. ad vivi. Reid & West Imp. London.



302 *A subsessilis* 305 *R. arcuatum* 306 *R. minutum*

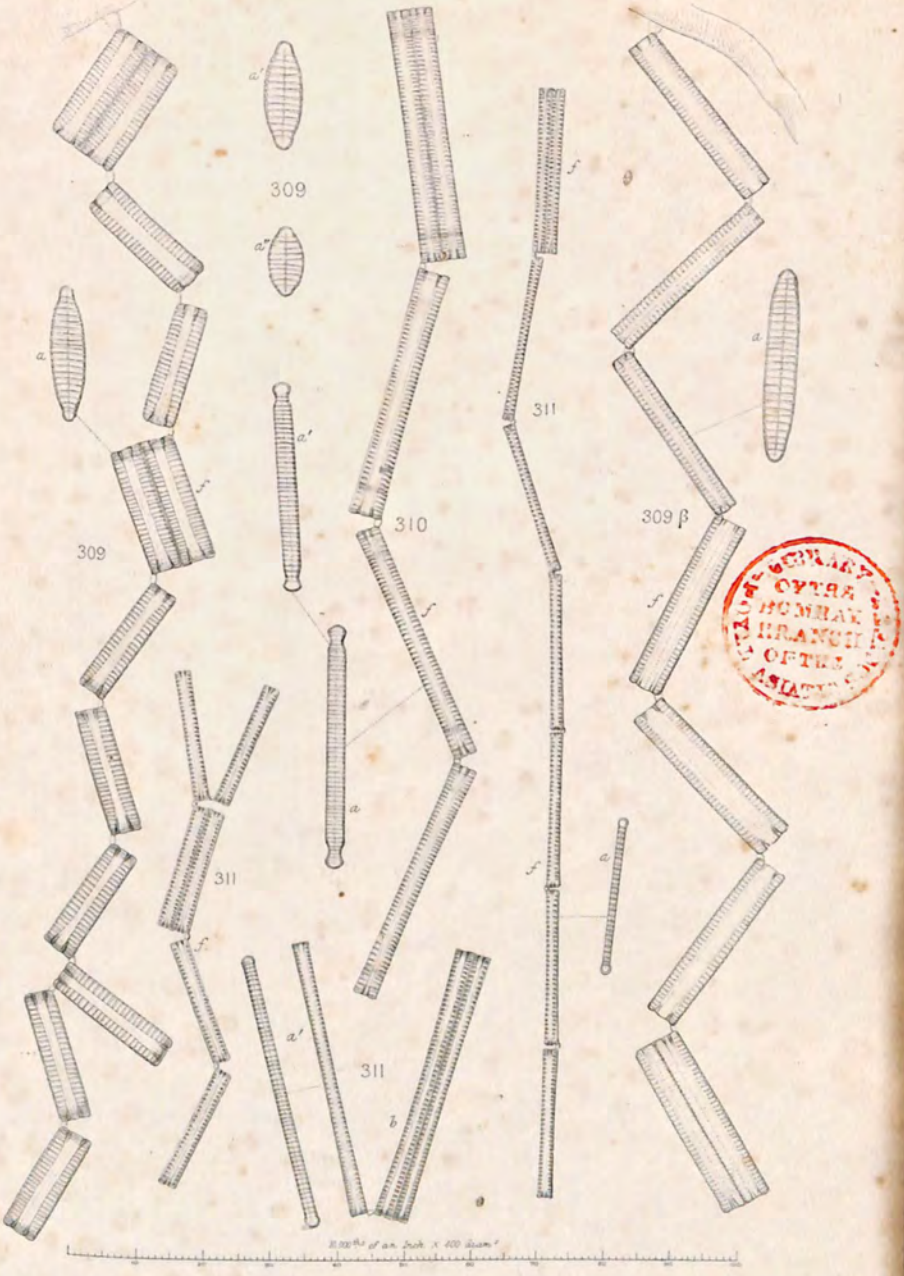
LIBRARY OF THE BOMBAY BRANCH OF THE



307 S. unipunctata. 308 T. lacustris

Tuffen West, sculp. ad nat.

Lond. & West. Eng. London.

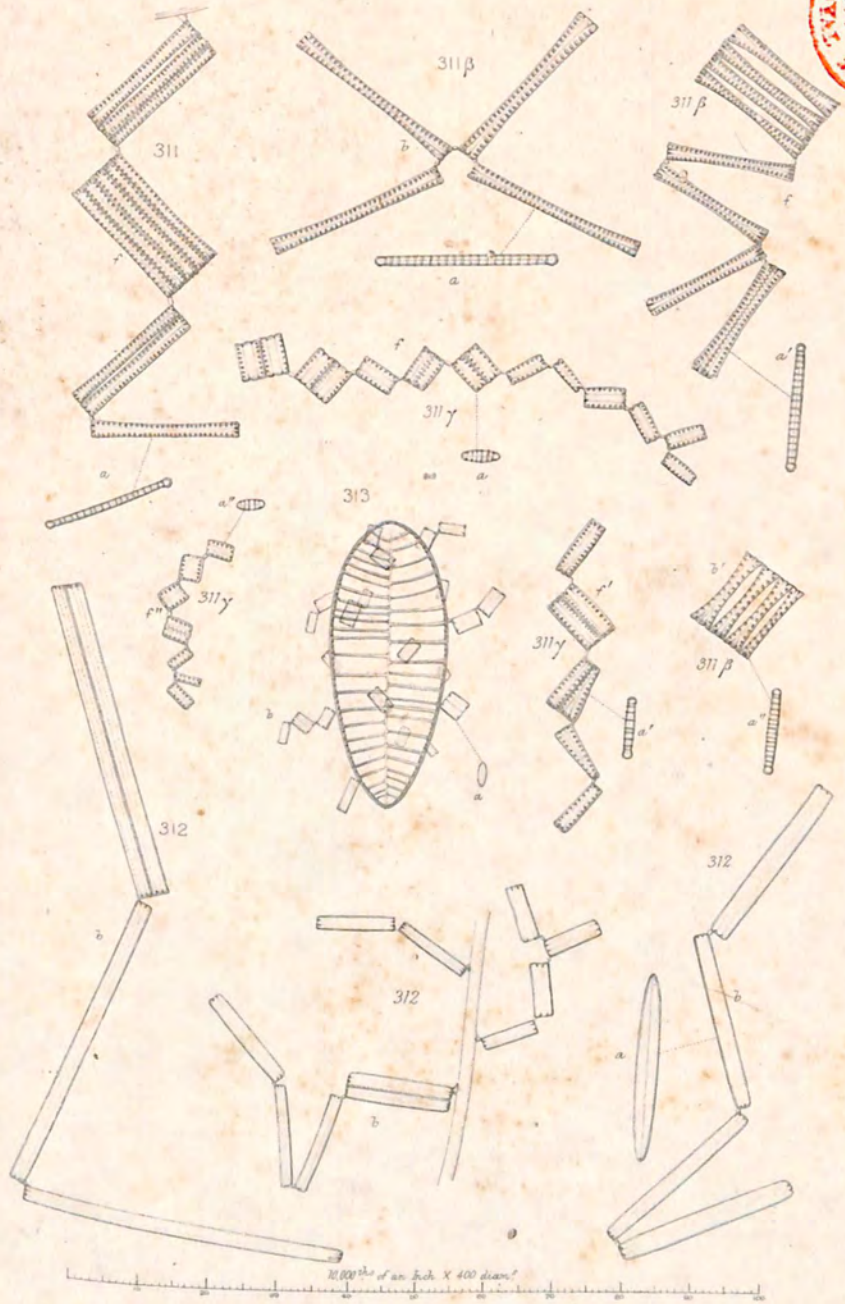


309 D vulgare & β. 310 D grande. 311 D elongatum.

BOMBAY BRANCH OF THE ASIATIC

Tuffen West. sculp. ad nat. Reed & West. Imp. London.

...OF THE ...BOTANY ...BRANCH ...OF THE ...ATIC SO...

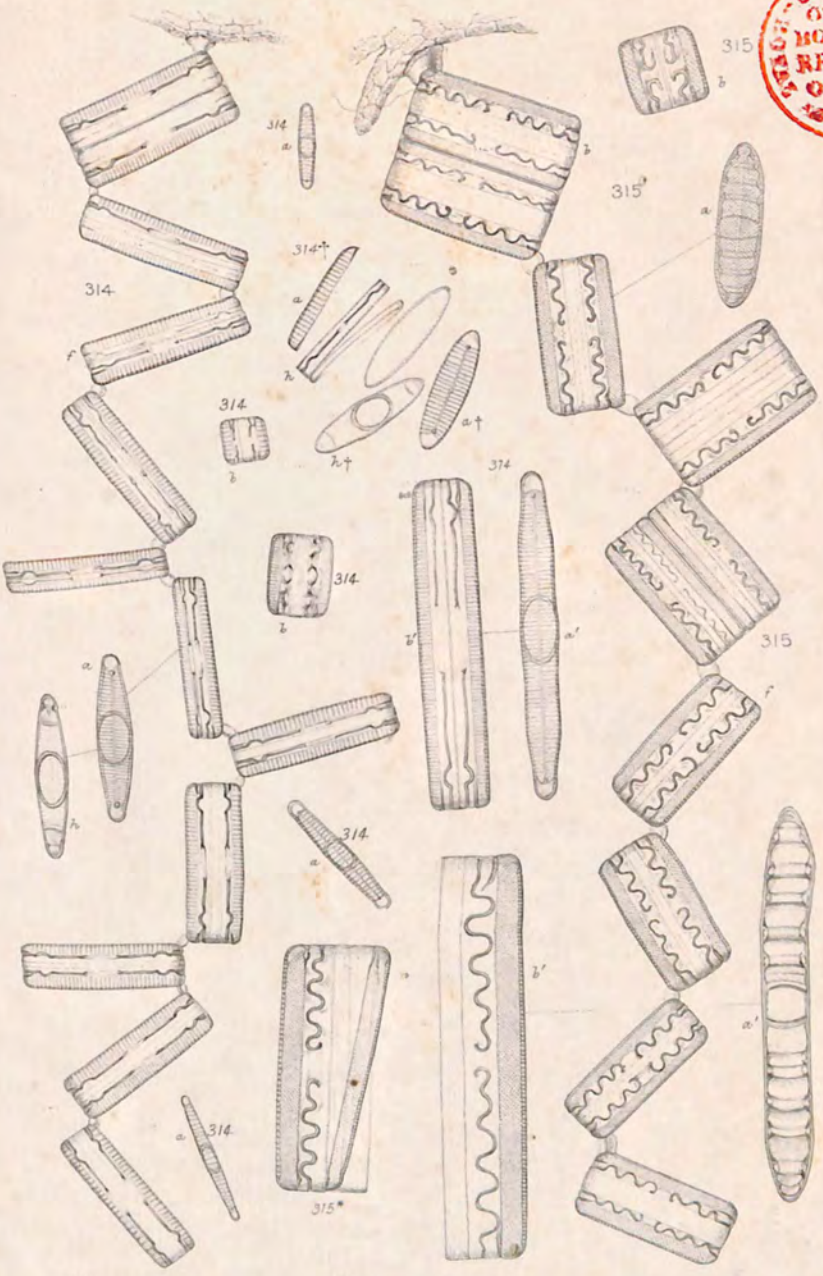


311 D. elongatum a, β, & γ. 312 D hyalinum. 313 D minimum

Tuffen West. lithp et nat.

Reed & Wm Imp. Hatton Garden

LIBRARY OF THE BOMBAY BRANCH OF THE

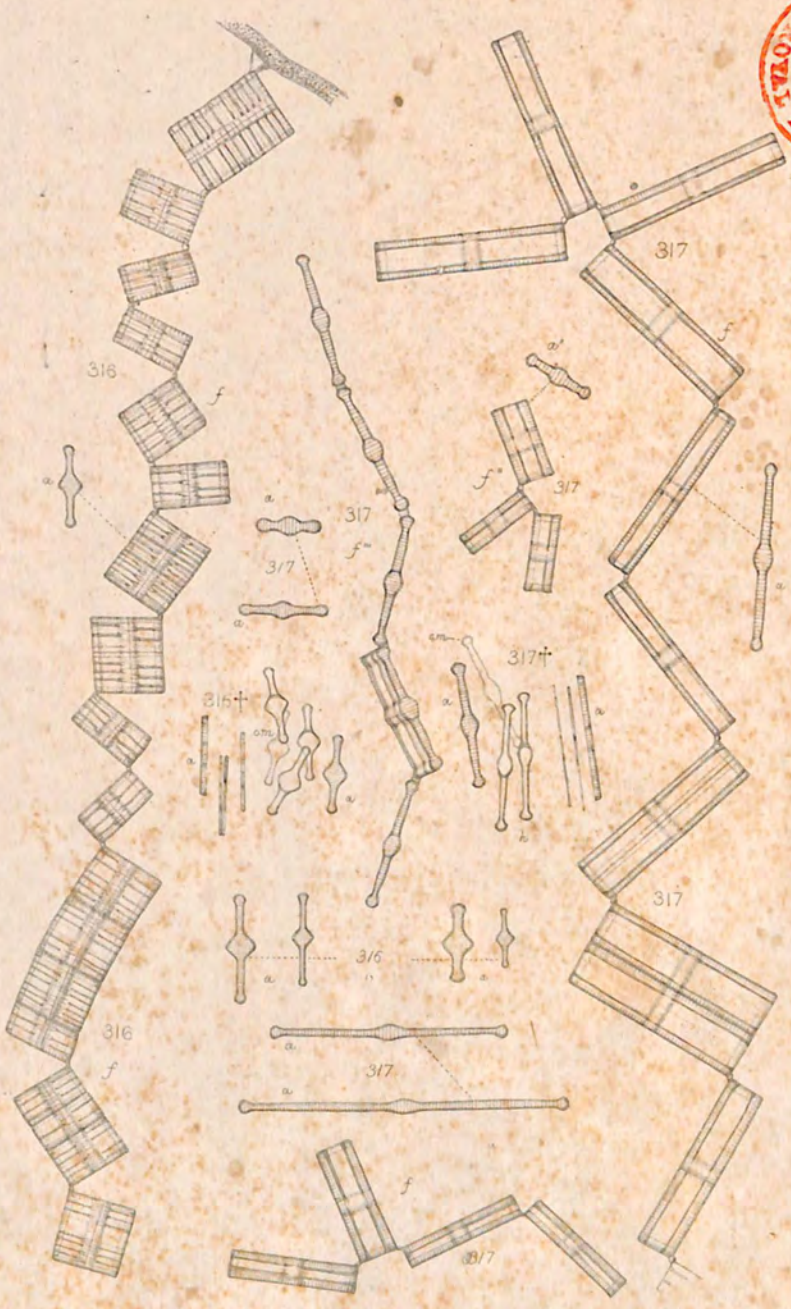


314. *G marina.* 315. *G serpentina.*

Edw. West sculp. ad nat.

Bell & Wm. Imp. London

BRANCH OF THE ASIATIC

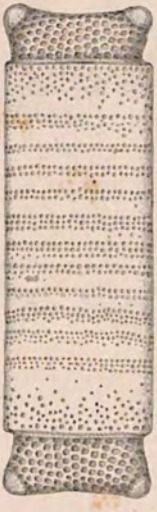
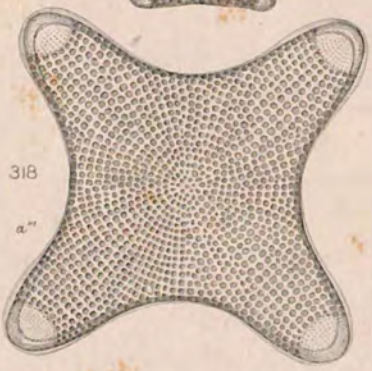


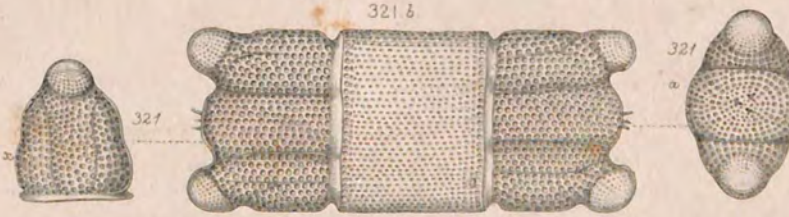
316 T flocculosa 317 T fenestrata

Walter West, sculp. et del.

Dan'l & West, Imp. Botan. Garden

BRANCH OF THE

AMPHITETRAS BIDDULPHIA Pl. XLIV.



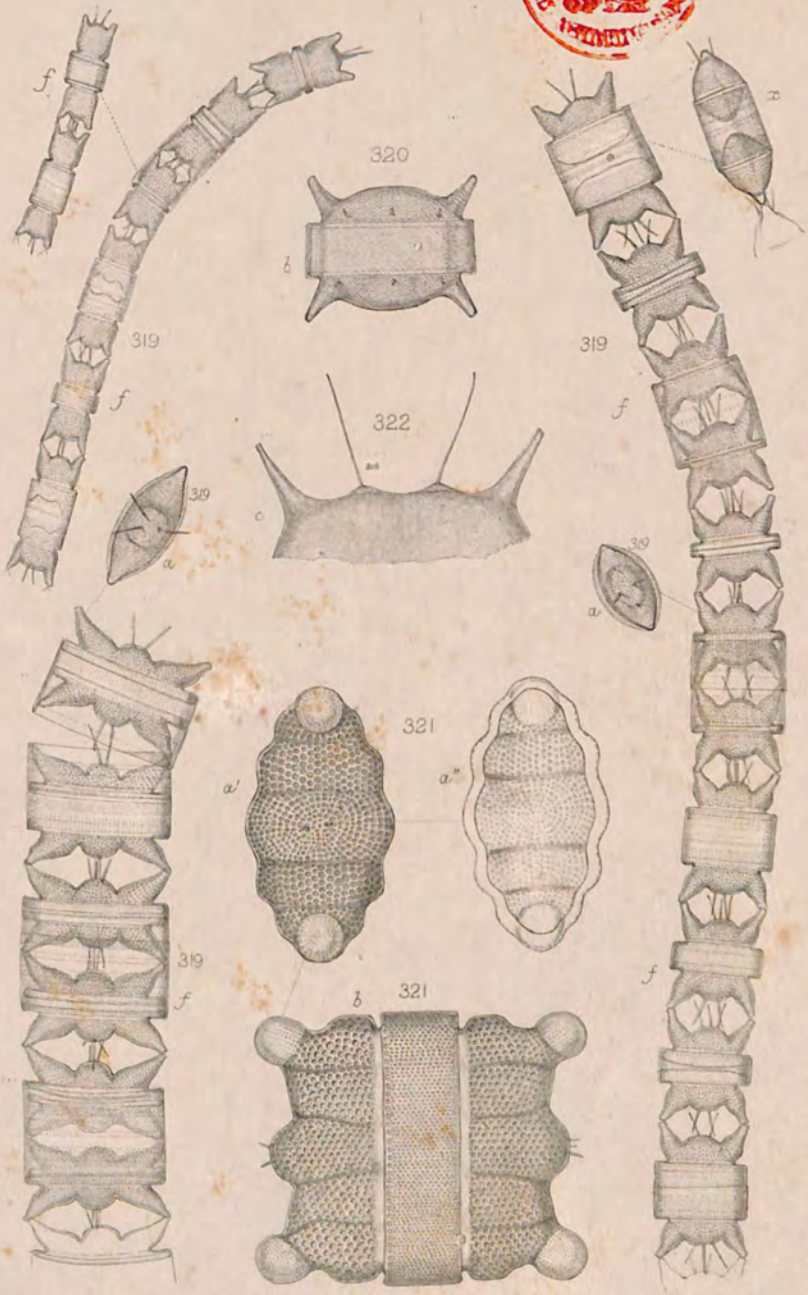


318 A antediluviana. 321 B pulchella.

Tuffen West sculp ad nat.

Fred.k West lith. London.

THE BOMBAY NATURAL OPEN



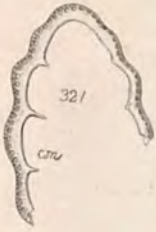
10,000ths of an inch. X 400 diam.

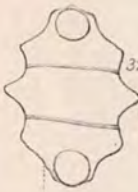
319 B. aurita. 320 B. Rhombus. 321 B. pulchella. 322 B. Baileyii.

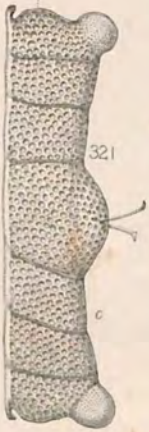
Tuffen West sculp. ad. nat.

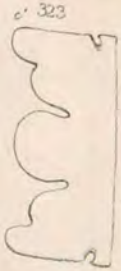
Ford & West Imp. London

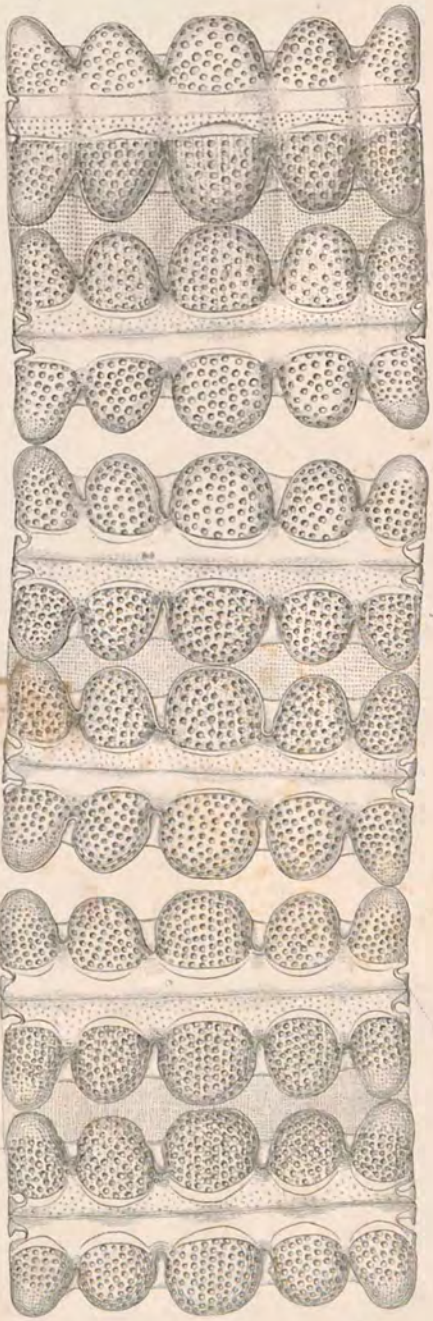
LIBRARY OF THE BOMBAY BRANCH OF THE ASIATIC

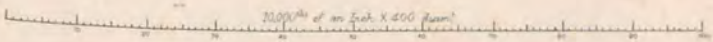










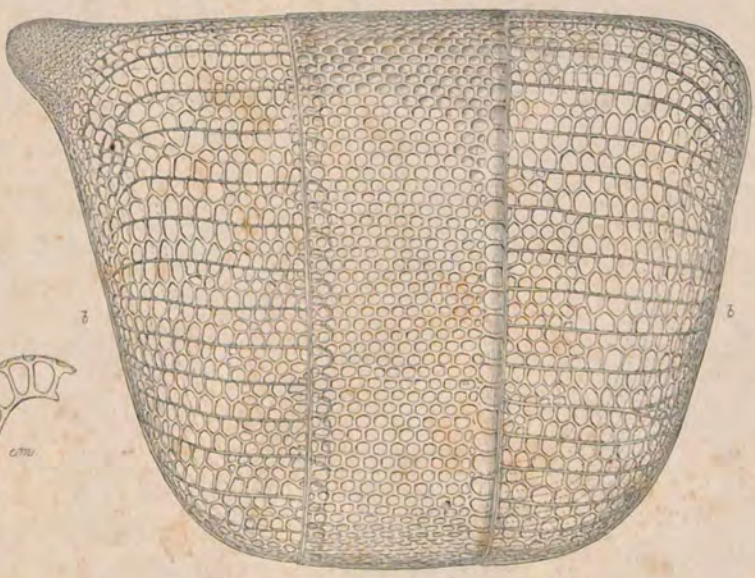


321. B. pulchella. 323. B. regina.

Tuffen West sculp. ad. nat.

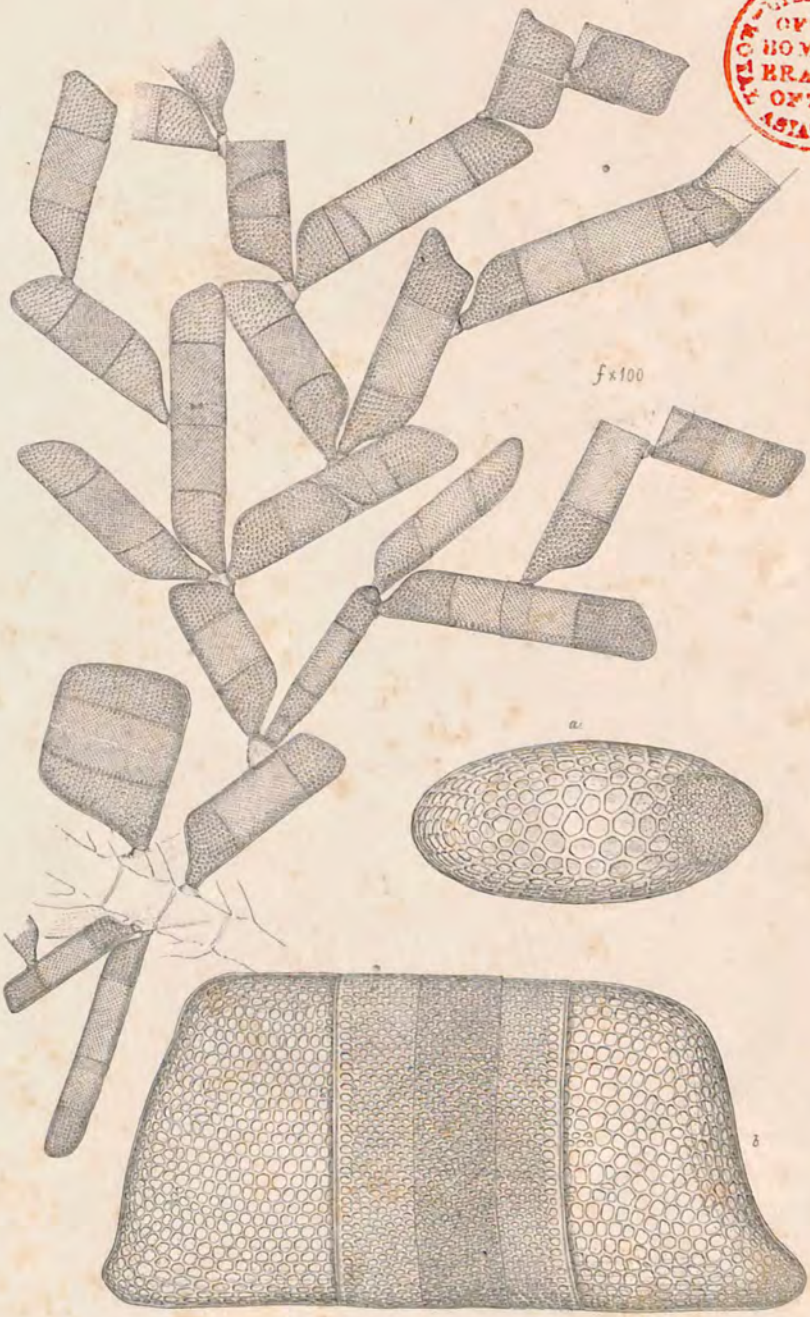
Ford & West Imp. London

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY



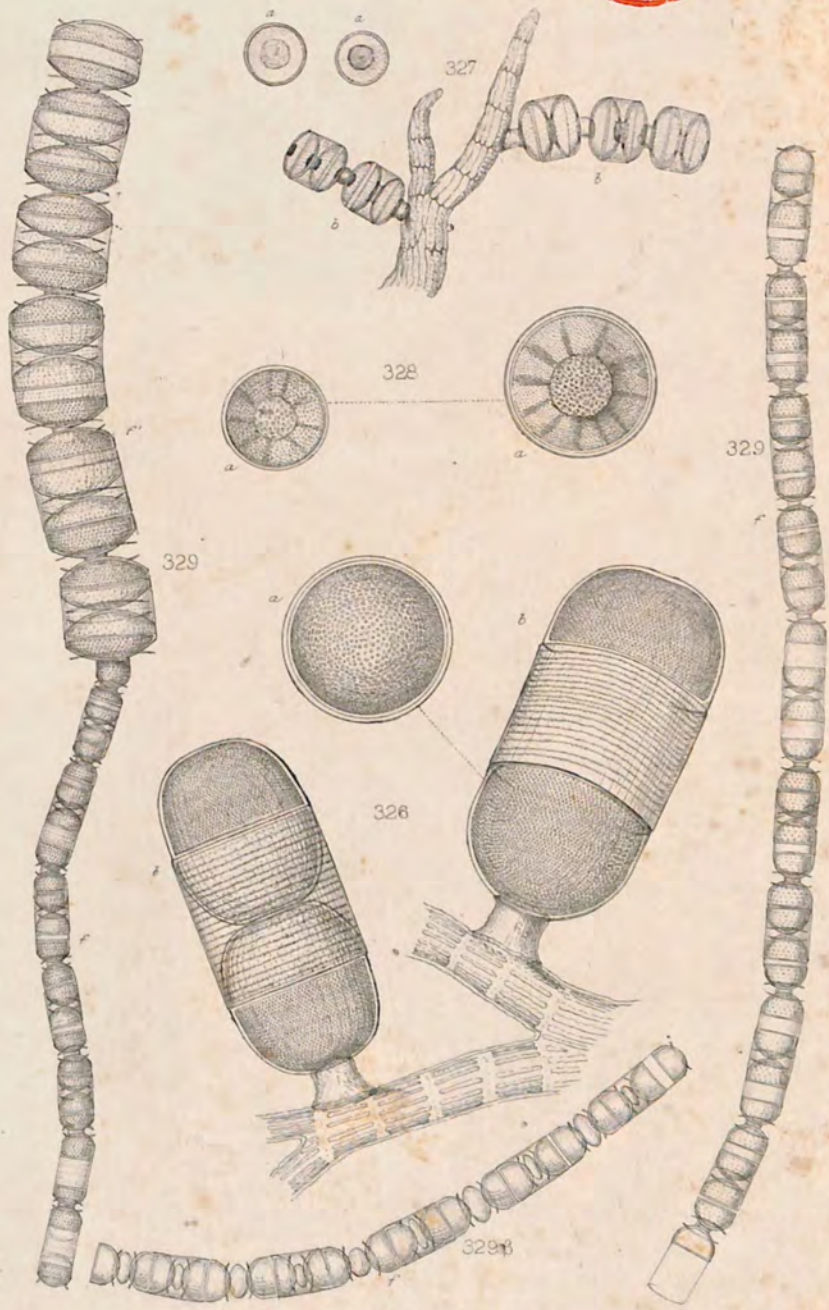
I. nervosa.

LIBRARY
OF THE
BOMBAY
BRANCH
OF THE
ASIATIC



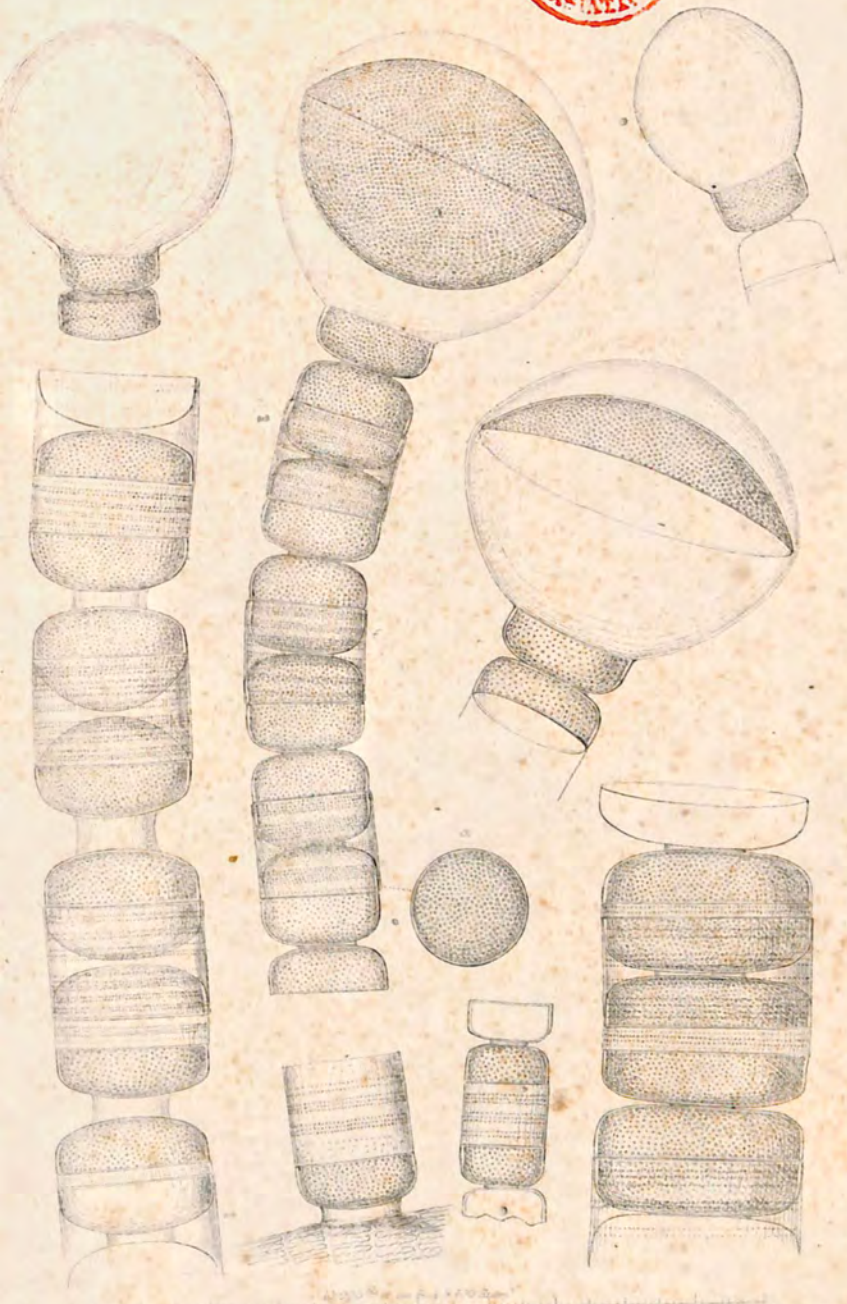
Icones

BRANCH OFFICE ASIATIC SOCIETY

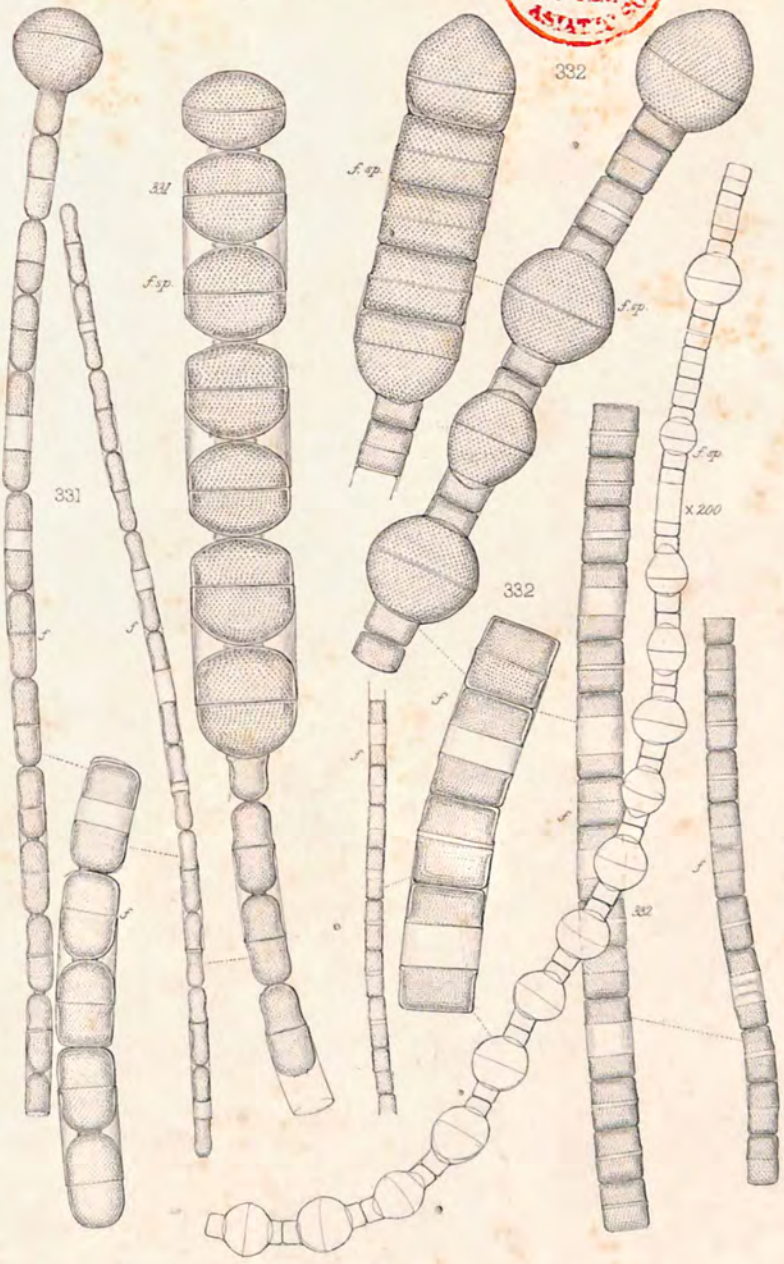


326 P. Montagnei. 327 P. thermodas 328 P. maculata. 329 M. nummuloides.

ROYAL ASIATIC SOCIETY
BOMBAY BRANCH
OPTHR



LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY


331
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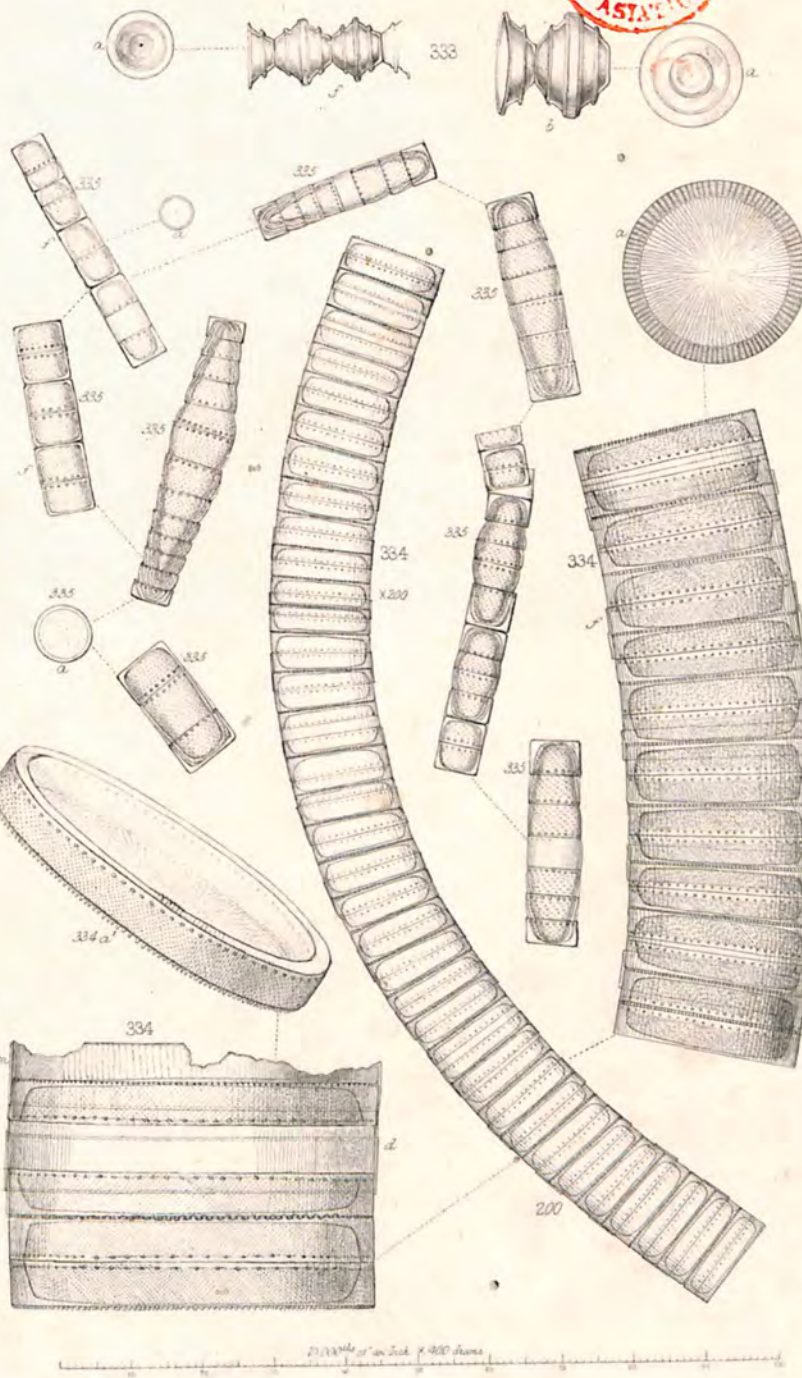
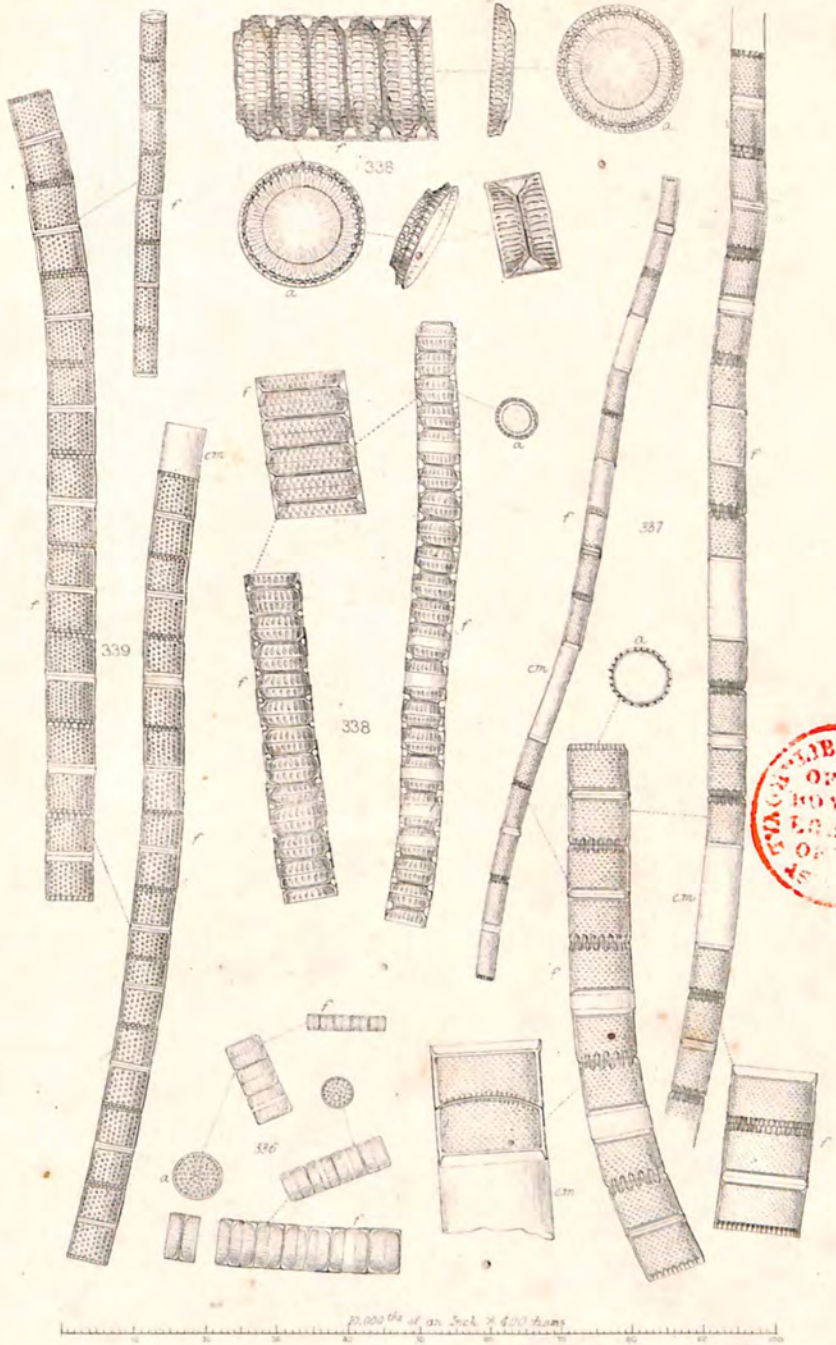
ROYAL ASIATIC SOCIETY BOMBAY BRANCH OF THE

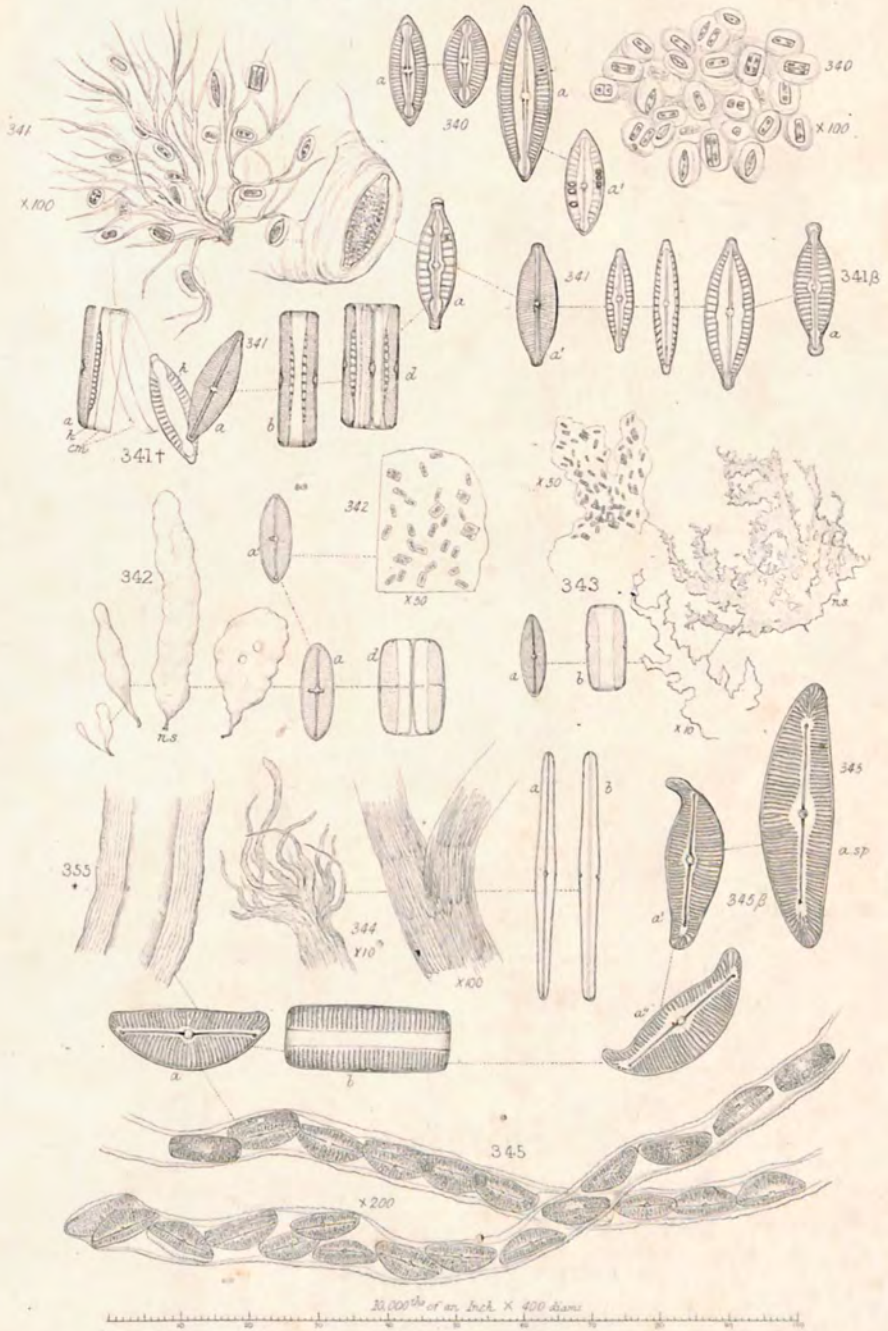


333 M. Westii. 334 O. arenaria. 335 O. Dickiei.



SMITHSONIAN INSTITUTION LIBRARIES

336. M. nivalis. 337. O. orichalcea. 338. O. marina. 339. O. punctata.



340 M. ? canceolata. 341 M. Smithii. 342 D. ulvoides
343 D. pinnata. 344 B. fragilis. 345 E. prostratum.

Dellon West. sculp. Fitch & West. imp.

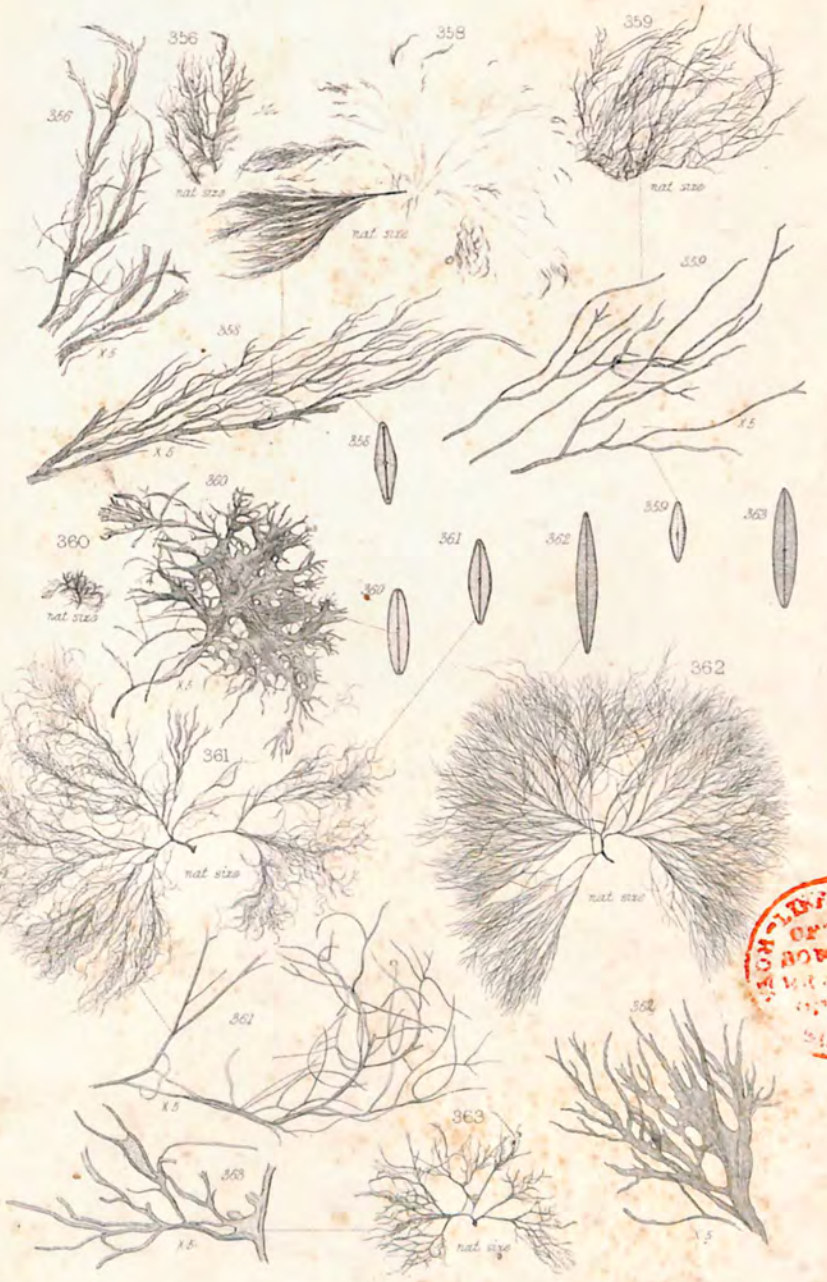
346 E. cæspitosum. 347 H. Martiana. 348 H. filiformis & β. 349 H. stymoidea.

LIBRARY OF THE BOMBAY BRANCH OF THE ASIATIC SOCIETY

Tuffen West, sculp. ad nat. Ford & West. Imp.

BRANCH OF THE ASIATIC SOC

350. C. eximium. 351. C. vulgare. 352. C. neglectum.
353. C. subcoharens. 354. S. cruciger. 355. S. helmintosum.



356 S. cruciger. 358 S. simoides. 359 S. confertum. 360 S. mucosum. 361 S. torquatum.
362 S. Smithii. 363 S. divergens.

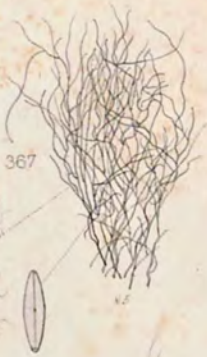
NATURAL HISTORY SOCIETY OF BOMBAY ASIATIC SOCIETY

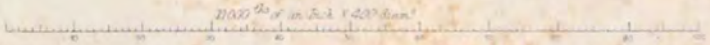
364 S Grevillii. 365 S. mollis. 366 S Dillwynii &B. 367 S. obtusum.

Tuffen West, sculp. et exc.

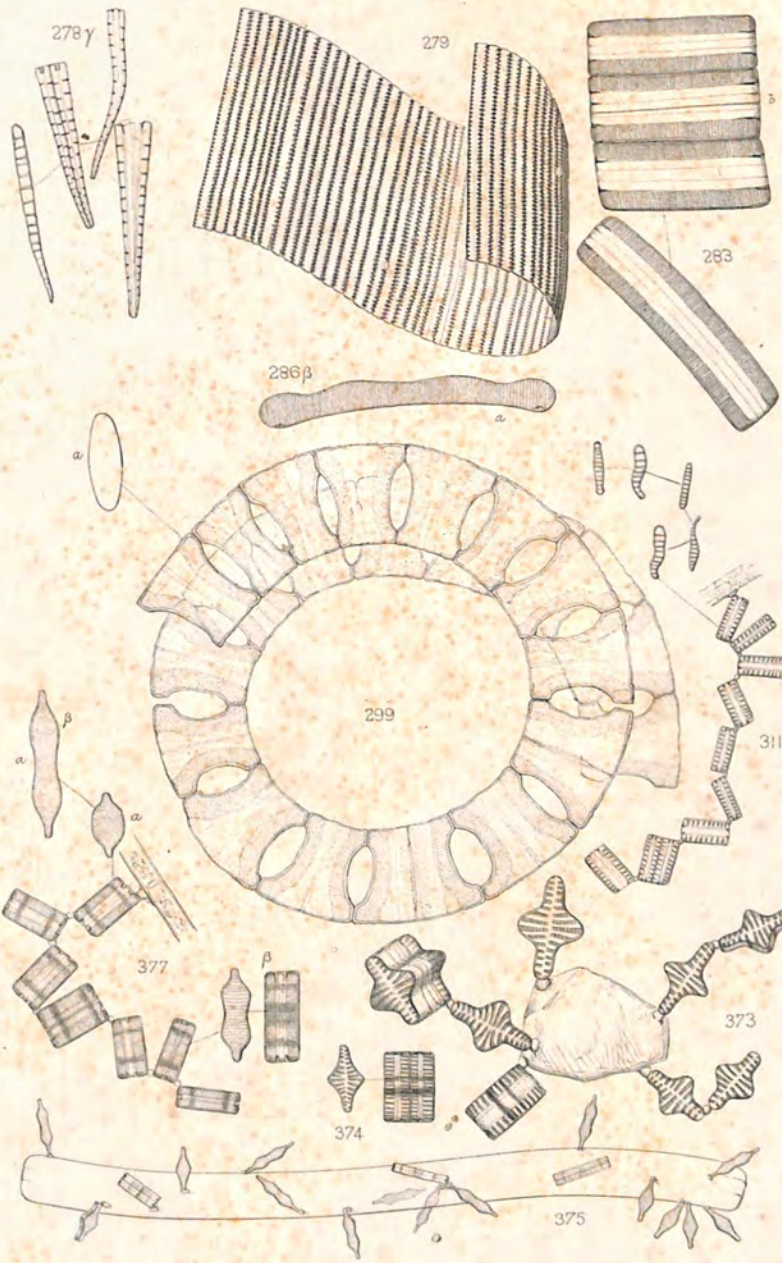
For A.A. West. Engr. 14, Bolton Row Mayfair.

LIBRARY
OF THE
BOMBAY
BRANCH
OF THE
ASIATIC



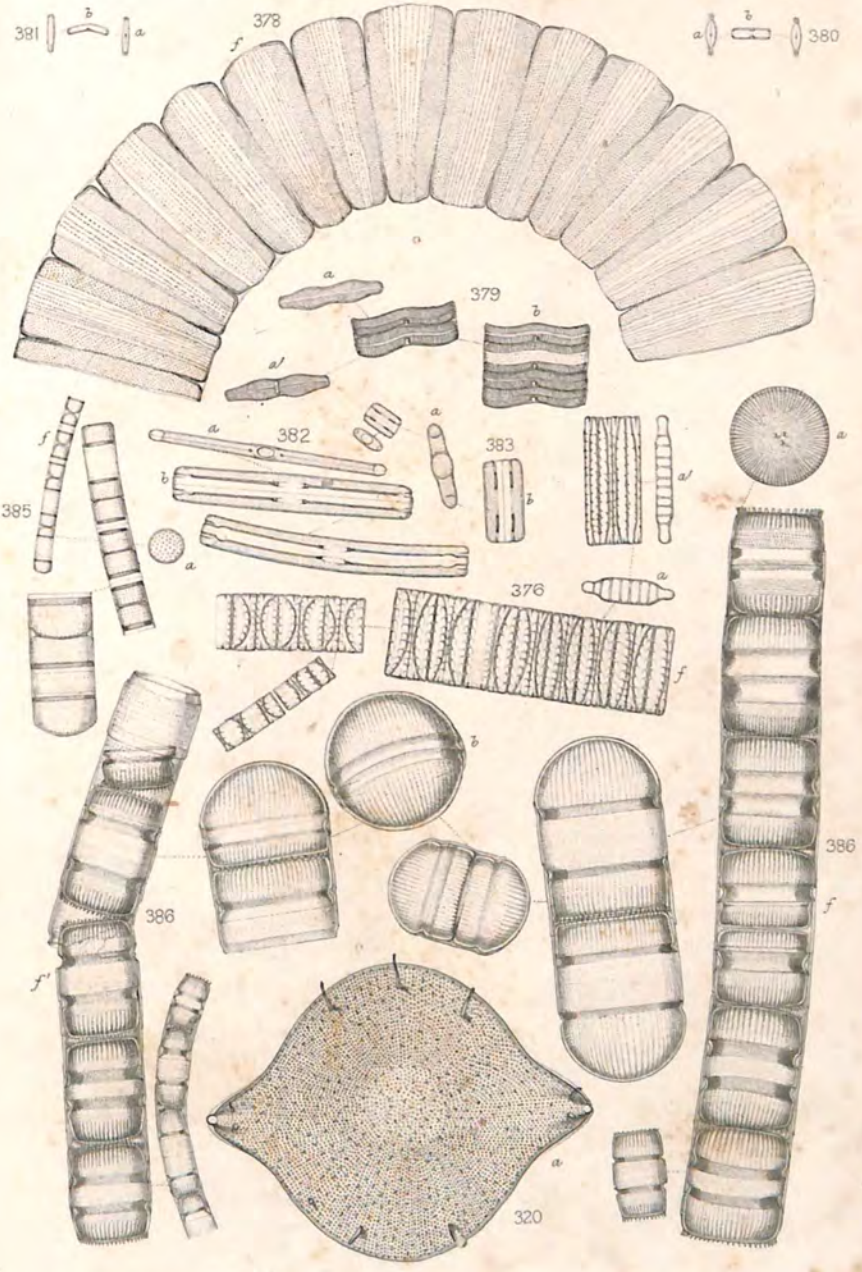


367. S. implicatum. & β. 369. S. ramosissimum. 370. S. laciniatum.
371. S. parasiticum. 372. S. gracillimum.



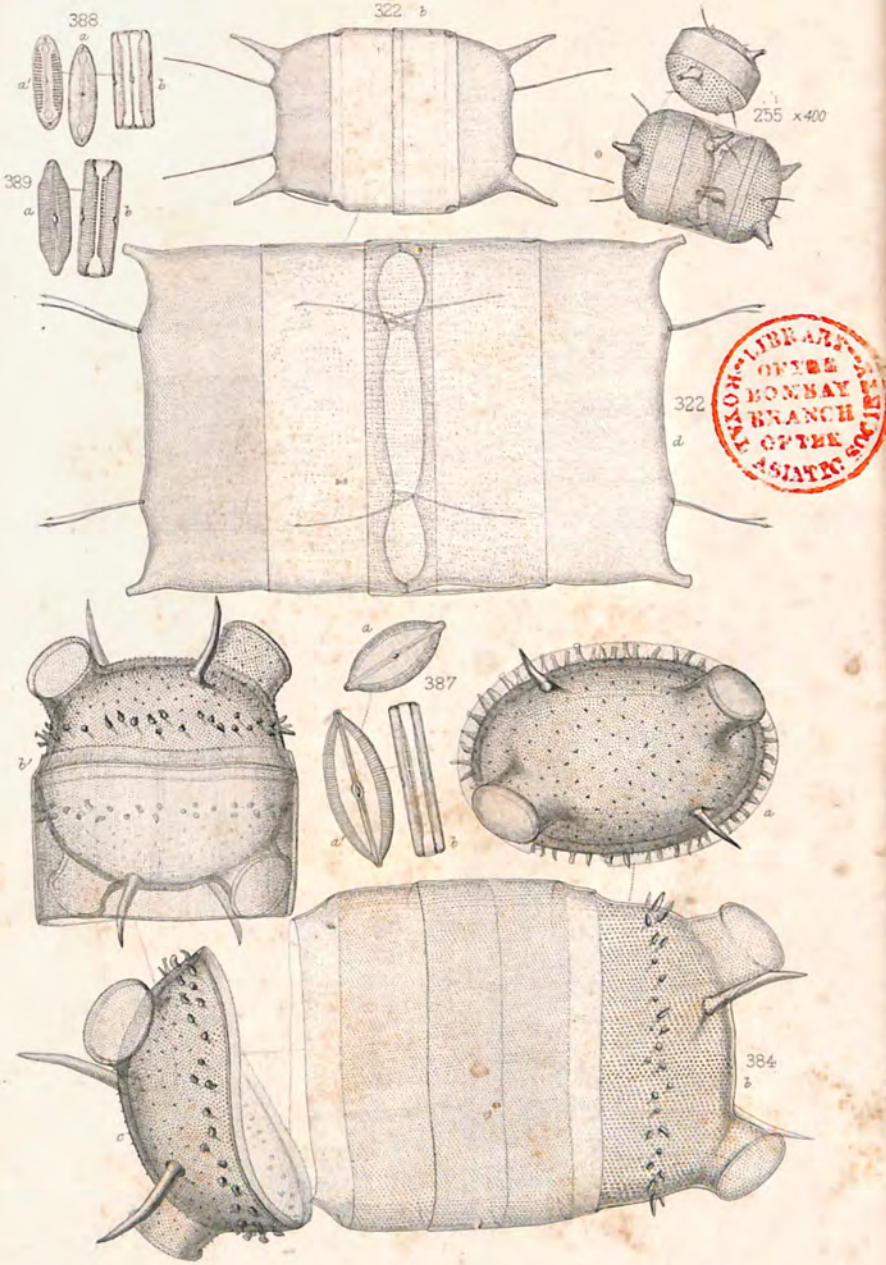
278. M. constrictum γ. 279. B. paradoxa. 283. H. Arcus. 286. H. majus β.
299. E. Zodiacus. 311. D. elongatum δ. 373. O. Harrisonii. 374. O. Harrisonii β.
375. O. parasiticum. 377. F. undata.

Ruffles Vien. sculp. ad nat. Reid & West. Imp.



10,000th of an Inch X 400 diam.²

320 B Rhombus 376 O anomalum 378 E Britannicus
379 A coarctatum 380 A microcephalum 381 A lineare
382 G maculatum 383 G Balfouriana 385 M distans 386 O spinosa



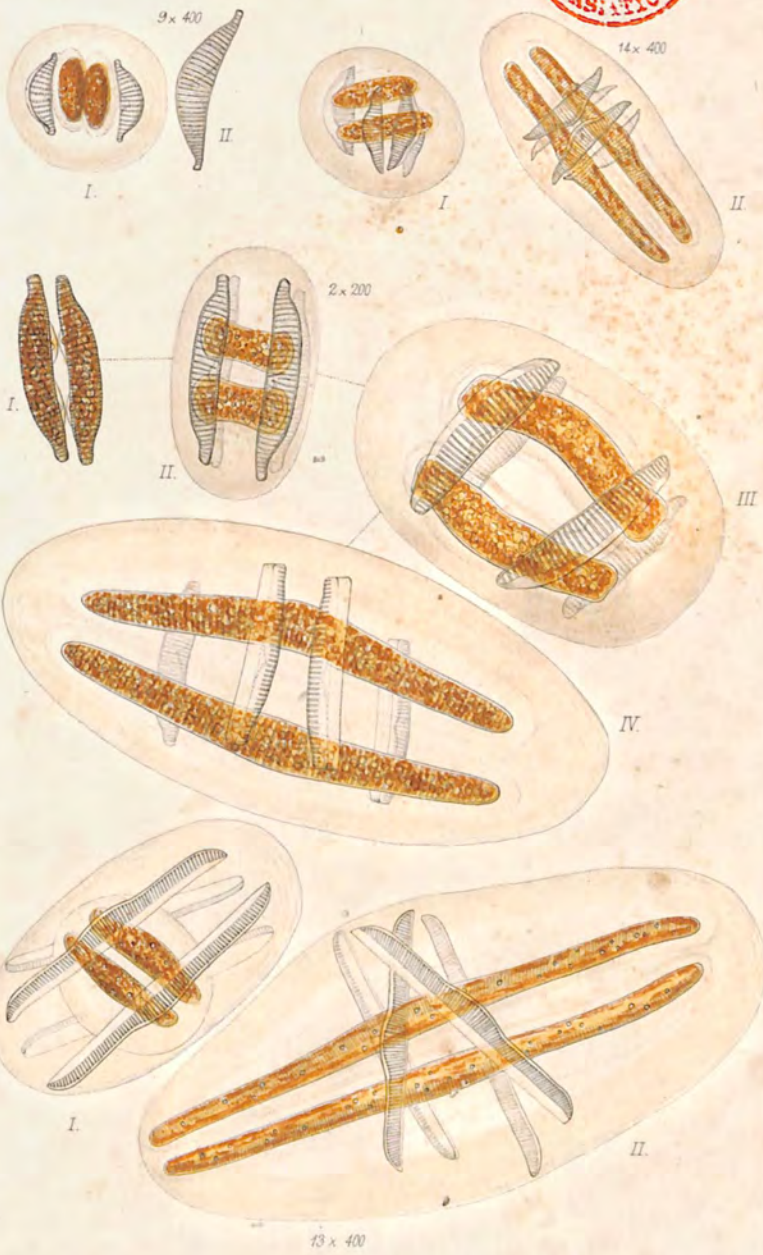
LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

10 000ths of an Inch X 400 diam.s

255 B radiatus 322 B Baileyi. 384 B turgida
387 M apiculata. 388 M Dawsoni 389 M Grevillei.

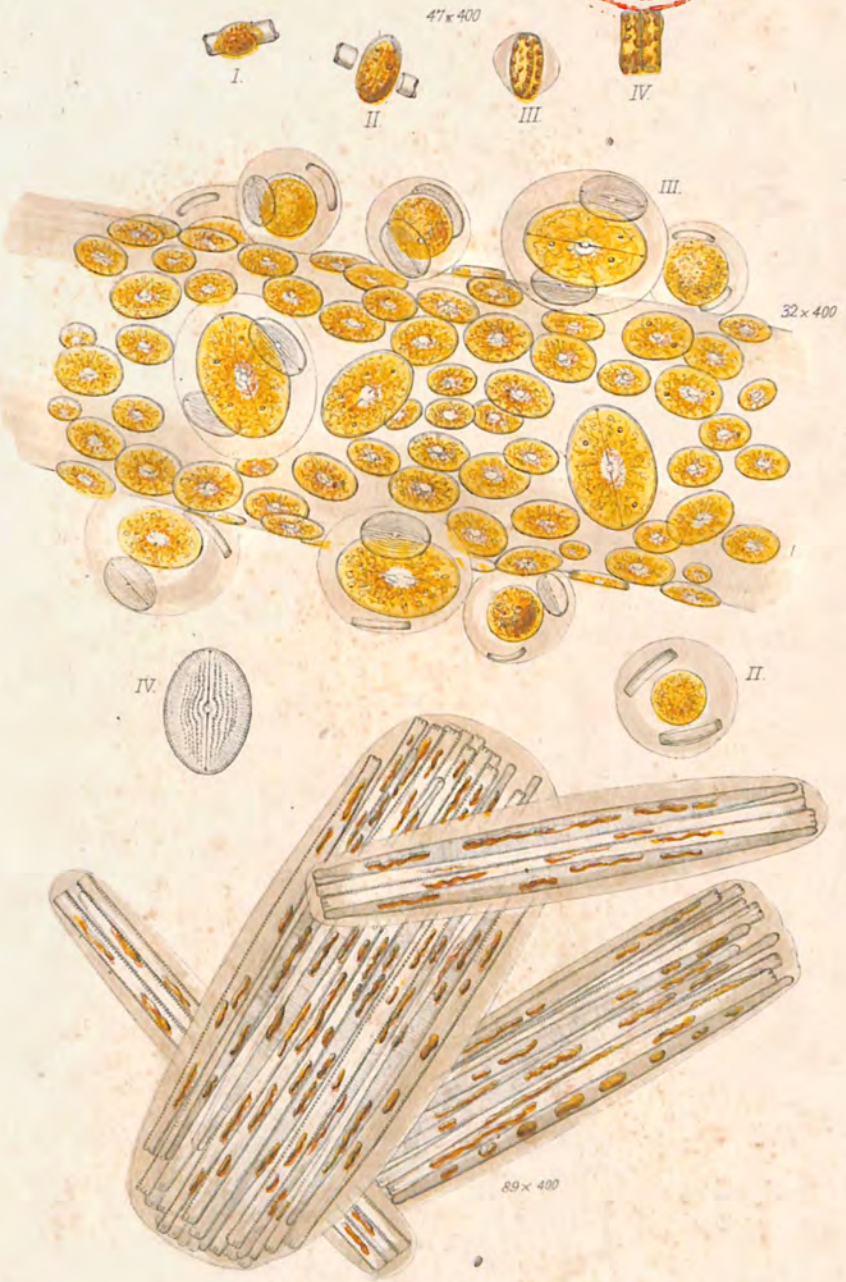
Taffin, West sculp. ad nat. Reid & West. Imp.

TAYLOR-LIBRARY-ALEXIOS OF THE BOMBAY BRANCH OF THE ASIATIC SOCIETY



2. Epithemia turgida. 9. Epithemia Sorex.
13. Epithemia gibba. 14. Epithemia ventricosa.

BOMBAY BRANCH OF THE ASIATIC



47. Cyclotella Kutzingiana 32. Cocconeis Placentula
89. Synedra radians.

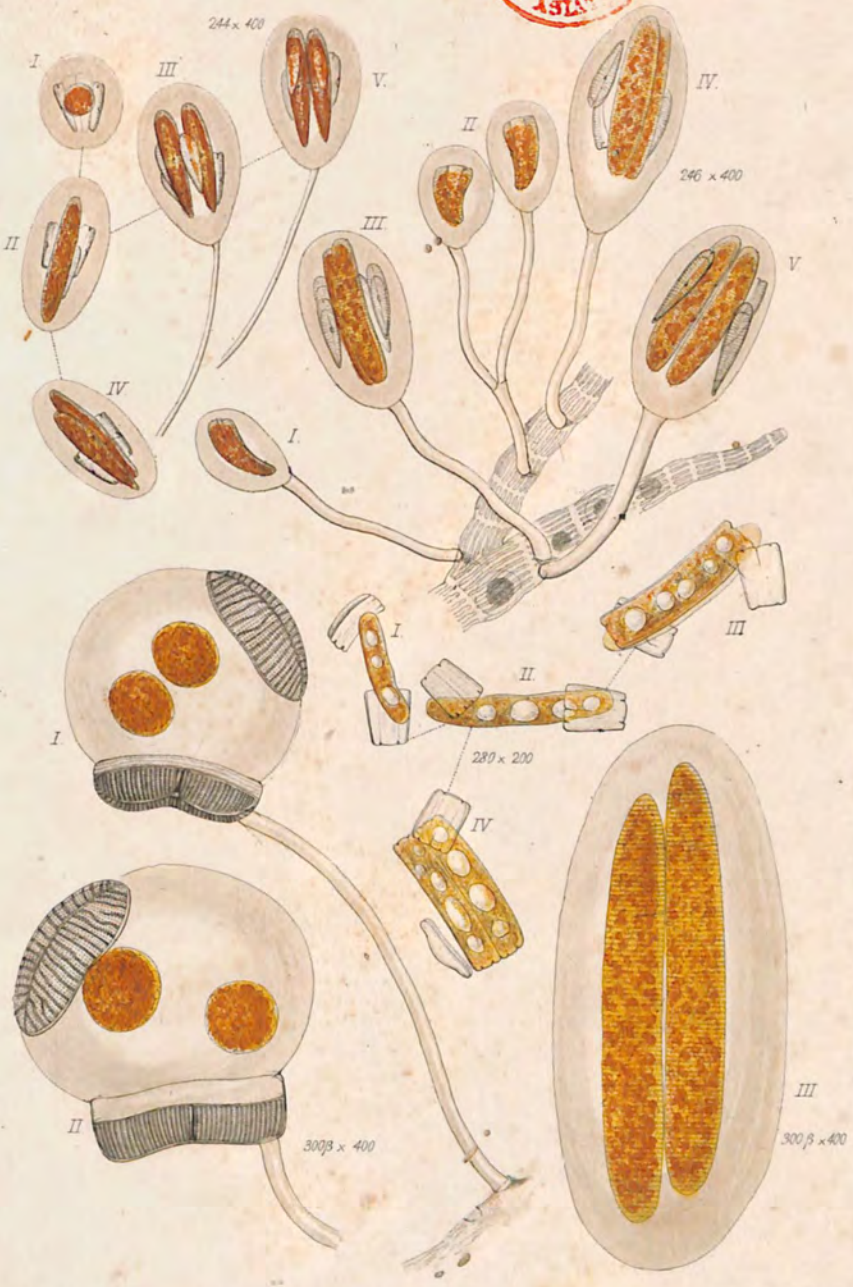
Tuffen West sculp. et lith.
Bird & West Imp.

ROYAL ASIATIC SOCIETY OF THE BOMBAY BRANCH OF THE ASIATIC SOCIETY

219. Cocconema lanceolatum. 221. Cocconema Cistula.
240 Gomphonema dichotomum. 245 Gomphonema curvatum.

Tuffen West. sculp. ad nat. Ford A. West. Imp.

ROYAL ASIATIC SOCIETY BOMBAY BRANCH

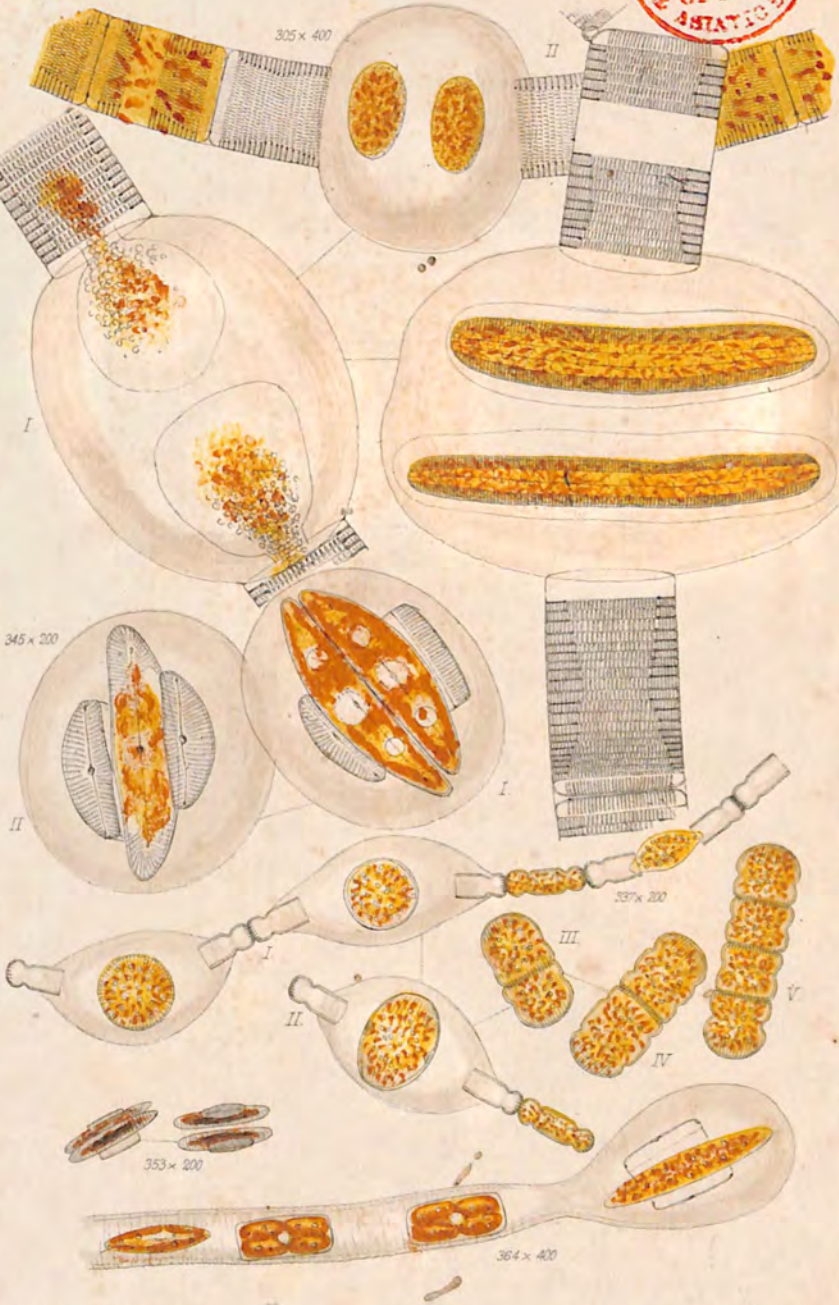


244 Gomphonema diraceum 246 Gomphonema marinum
280 Himantidium pectinale 300β Acnanthes longipes β

Griffiths, West, sculp. et lith.

Byrd & West, Chromo. Imp.

BOMBAY BRANCH OF THE ASIATIC SOCIETY



305. Rhabdonema arcuatum. 337 Orthosira orichalcea.
345 Encyonema prostratum. 353 Colletonema subcohæreus.
Schizonema Grevillei.

Tuffen West, sculp. & mar.

Reed & West, Chromo. Engs.

CATALOGUE

OF

ACHROMATIC MICROSCOPES,

&c.

MANUFACTURED BY

SMITH AND BECK,

TO WHOM

THE COUNCIL MEDAL OF THE GREAT EXHIBITION OF 1851

AND

THE FIRST CLASS MEDAL OF THE FRENCH EXHIBITION OF 1855

HAVE BEEN AWARDED FOR

"THE EXCELLENCE OF THEIR MICROSCOPES."

---

6 COLEMAN STREET, LONDON.
MARCH 1856.

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Explanation of the 3 Classes of Achromatic Microscopes,

Manufactured by Smith and Beck.

A Compound Achromatic Microscope consists, essentially, of an Object-Glass, and an Eye-piece; so called, because they are respectively near the object and the eye when the Instrument is in use. The Object-Glass screws, and the Eye-piece slides, into opposite ends of a tube termed the Body, and upon the union of the two the Magnifying Power depends. But some form of *Stand* is invariably employed to carry the *Magnifying Power*, to hold, or to give traverse to the object, and to receive various apparatus for *Illumination*.

Under this general description the following Microscopes may be arranged in *Three Classes*:—

In the *First*, the *Magnifying Power*, the *Stand*, and the *Illumination* are carried to the greatest possible perfection.

In the *Second*, the same *Magnifying Power* is combined with a *Stand*, and apparatus for *Illumination*, less expensive but very efficient.

In the *Third*, the capabilities of all the parts are limited, but yet equal to the requirements of many, and of considerably less cost.

Although the following Lists of Apparatus are complete in each Class, any portion of them can be ordered, and the Stands are not required by the makers for subsequent additions.

ACHROMATIC OBJECT-GLASSES*.

For the 1st & 2nd Class Stands (Nos. 1, 2, 3 & 4).

THE increase of the angle of aperture of the Object-Glasses in the following Table is more especially worthy of notice in the lower powers, which, adjusting through considerable thickness of glass, or some depth into water, will, with a large aperture, exhibit those objects which are the most frequently examined by the naturalist, with a definition that a smaller angle of aperture cannot give. One of these Object-Glasses, a 4-10ths (erroneously called "half-inch"), is thus alluded to in the "Reports of the Juries of the Great Exhibition" (p. 266), Class X., No. 253.

> "The half-inch focus of 70° aperture is a wonderfully fine combination, easily showing objects considered difficult for a one-eighth inch focal length a little more than a year since, and bearing the application of the higher eye-pieces in an unprecedented manner."

Focal length.	Linear Magnifying Power nearly. With Eye-Pieces.	No. 1	No. 2	No. 3	Angle of aperture about	Price. £	s.	d.	Lieberkuhn additional.
1 1/2 inch	Draw-tube closed	20	45	80	13 degrees	3	0	0	15s.
	Add for each inch of tube drawn out	4	6	8					
2/3 inch	Tube closed	60	105	180	27 degrees	3	3	0	11s.
	Add for each inch of tube.....	7	12	20					
4/10 inch	Tube closed	120	210	350	55 degrees	5	5	0	10s.
	Add for each inch of tube.....	12	20	35					
Ditto	Ditto	do.	do.	do.	65 degrees	6	6	0	10s.
Ditto	Ditto	do.	do.	do.	75 degrees	7	7	0	10s.
1/5 inch	Tube closed	240	430	720	85 degrees	6	6	0	
	Add for each inch of tube.....	30	45	80					
Ditto	Ditto	do.	do.	do.	100 degrees	7	7	0	
1/8 inch	Tube closed	450	760	1300	120 degrees	10	10	0	
	Add for each inch of tube.....	40	60	115					

The Erecting Glass for low power.....£1 0 0

The magnifying power of this glass with the 2-3rds Object-Glass and employing eye-pieces Nos. 1 & 2, is from 5 to 150.

* These Object-Glasses can be adapted to Ross' or Powell and Lealand's Microscopes without the instruments being required for that purpose.

First Class Microscope Stands.—Nos. 1 & 2.

These Stands are contrived for an easy and most accurate mode of applying every kind of illumination; one of similar construction was shown by S. and B. at the Great Exhibition of 1851, and is thus mentioned by the Jury.

"The Stand is excellent in principle; the body, stage, and appliances beneath, are all carried on one stout bar, on the recommendation of Mr. G. Jackson, by means of which the centring of the Achromatic illumination is rendered easy and certain; and on any tremor being communicated to the Instrument, it is equally distributed over the whole of the working parts."

(Reports of the Juries, p. 266, Class X. No. 253.)

	£	s.	d.
No. 1. Improved Large Microscope. The limb continued under the stage, and with cylindrical fitting and rack-work, for applying all illuminating apparatus with ease and accuracy; mounted on two pillars and cones, with revolving base to tripod; body with quick and slow motions, graduated sliding tube, and two eye-pieces; stage about half an inch thick, with vertical and horizontal actions (given by rack-work and screw, or lever), sliding and revolving planes, and spring clamping piece; diaphragm with revolving and removeable fittings; large plane and concave mirrors, with lengthening arm, and sliding on a triangular bar; pliers, joint and forceps, and two glass plates	22	0	0
Best Upright Case in Spanish mahogany, with two boxes for apparatus	4	10	0
Best Upright Case with one box	3	15	0
Upright Case in Honduras with two boxes	3	3	0
do. do. one box	2	10	0
No. 1. Improved Large Microscope, the same as the above, but made very portable	25	0	0
Strong Spanish Mahogany Case for ditto, with covered dovetails (19 in. long by 9 in. wide, and 4 in. deep)	3	10	0
No. 2. Improved Smaller Microscope, on the same principle, and with the same actions as No. 1, but with single pillar	18	0	0
Best Upright Case in Spanish mahogany, with box for apparatus	3	10	0
do. Honduras do. do.	2	10	0
Strong Flat do. in Spanish, and covered dovetails	1	15	0

First Class Microscope Stands.—Nos. 1 & 2.

APPARATUS.	£	s.	d.
3rd Eye-piece for No. 1 Stand	0	17	6
do. do. No. 2 do	0	15	0
Indicator to No. 1 Eye-piece	0	5	0
do. No. 2 do.	0	5	0
do. No. 3 do.	0	5	0
Achromatic Condenser on an improved construction of two powers, and revolving diaphragm, to give various illuminating pencils, from 80° to 25°, also stops for the central rays, complete with adjustments	5	0	0
Achromatic Condenser without diaphragm, apertures 60° and 20°, brass work with adjustments	2	10	0
Achromatic Condenser, brasswork of, with adjustments	1	0	0
Right Angle Prism for reflecting the light more perfectly than the mirror, with adjustments and fittings to the triangular mirror stem complete, and the reflecting surface uncovered for the convenience of wiping	2	10	0
Amici's Prism for oblique light, mounted on an improved plan, and the reflecting surface uncovered	2	2	0
Nachet's Prism for oblique light, with accurate revolving fitting	1	1	0
Wenham's Parabolic Reflector, giving a dark-field with an Object-Glass of 100° of aperture, adjusting stop and fittings	1	15	0
Polarizing Apparatus of two Nicol's Prisms, with revolving fittings	2	5	0
Darker's Series of Selenites, which give 13 different colours and their complementary tints, mounted on an improved plan for their more accurate and easy appliance	3	15	0
Selenite Film of two colours	0	5	0
Black Glass Polarizer, with fitting	0	15	0
Two Double Image Prisms and Selenite film, with fittings to Eye-piece, and brass plate with holes	2	2	0
Crystals to show rings round the optic axis and fitted to Eye-piece.....each from	0	10	6
Tourmalines .....from	1	0	0
Large Bull's Eye Condensing Lens on stand	1	1	0
Smaller Condensing Lens, with ball-and-socket joint to limb	0	18	0
Side Silver Reflector, with complete fittings to limb	1	1	0
Dark Wells of three sizes, with holder	0	12	6
Brooke's double Nose-piece	1	10	0
Camera Lucida, Wollaston's	1	0	0
Micrometer, with Jackson's adjusting screw and fittings to Eye-piece	1	0	0
Micrometer for stage, divided into 100ths and 1000ths of an inch	0	10	0
Compressorium	1	0	0
do. Wenham's, for use with Parabola	0	7	6
Screw Live Box	0	14	6
Large Live Box	0	8	6
Smaller do.	0	6	6
Large Glass Trough, with wedge and spring complete	0	8	6
Frog Plate, with bag, &c., complete	0	10	6
Glass Tubes, set of three	0	2	6
Three-pronged Forceps	0	8	6

Second Class Microscope Stands.—Nos. 3 & 4.

	£	s.	d.
No. 3. *Best Student's Microscope*, with uprights and joints, quick and slow motions to body, graduated sliding tube, and two eye-pieces; thin stage, with vertical and horizontal actions by rackwork, sliding and revolving planes, and spring clamping piece; diaphragm with revolving and removeable fittings; double mirror, with lengthening arm; pliers, forceps, and two glass plates	12	12	0
No. 3. *Best Student's Microscope*, the same as above, but with plain stage, consisting of sliding piece and clamping spring	8	8	0
Upright Case for No. 3 Stand in Honduras mahogany, with box for apparatus	2	10	0
Strong flat case for ditto in Honduras, dovetailed	1	5	0
No. 4. *Smaller Student's Microscope*, with quick and slow motions to body, one eye-piece, sliding tube, stage with sliding piece and clamping spring, revolving and removeable diaphragm, single concave mirror, pliers, forceps, glass plate and mahogany case	5	10	0

Apparatus to Nos. 3 & 4 Stands.

No. 3 *Eye-piece* for No. 3 or 4 Stand	0	15	0
Indicator to No. 1 Eye-piece	0	5	0
do. No. 2 do.	0	5	0
do. No. 3 do.	0	5	0
Achromatic Condenser of two powers, 60° and 20° of aperture, rackwork and adjustment to brasswork	3	0	0
Achromatic Condenser as above, with sliding fitting, and no adjustment to brasswork	2	5	0
Achromatic Condenser, Lenses of	1	10	0
Nachet's Prism for oblique light	0	18	0
Wenham's Parabolic Reflector, with adjusting stop	2	10	0
Polarizing Apparatus of two Nicol's Prisms, with revolving fittings, and one plate of selenite	2	10	0
Two Double Image Prisms and Selenite Film, with fittings to Eye-piece, and brass plate with holes	2	2	0
Crystals to show rings round the optic axis and fitted to Eye-piece.....each from	0	10	6
Tourmalines.....from	1	0	0
Darker's Selenite Stage	2	2	0

Second Class Microscope Stands.—Nos. 3 & 4.

Apparatus (*continued*).

	£	s.	d.
Small Condensing Lenses, on stand, with complete movements	0	12	0
Side Silver Reflector, on stand, with complete movements...	1	1	0
Dark Wells of three sizes, with holder	0	12	6
Brooke's Double Nose-piece	1	10	0
Camera Lucida, Wollaston's	1	0	0
Micrometer, with Jackson's adjusting screw and fittings to Eye-piece	1	0	0
Micrometer for stage, divided into 100ths and 1000ths of an inch	0	10	0
Compressorium	1	0	0
Ditto, Wenham's, for use with Parabola	0	7	6
Screw Live Box	0	14	6
Large Live Box	0	8	6
Smaller ditto	0	6	6
Large Glass Trough, with wedge and spring complete	0	8	6
Frog Plate, with bag, &c., complete	0	10	6
Glass Tubes, set of three	0	2	6
Three-pronged Forceps	0	8	6

Microscope Tables.

Walnut-wood Table, with improved revolving fitting, on handsome pillar and claw, with leather top	8	8	0
Iron Table, with revolving top	5	5	0

Microscope Lamps.

Improved small Camphine Lamp, with glass cap, to prevent evaporation of the spirit when not in use	2	2	0
Best Argand Lamp, with blue chimney for burning oil	1	5	0

Gas Lamps made to order.

PRICES OF THE THIRD CLASS,

OR

EDUCATIONAL MICROSCOPE

AND

APPARATUS.

This Microscope is intended to meet a want that has been much felt by students and others, who have been desirous of possessing an instrument equal to their requirements, whether in Physiology, Chemistry, or the minute forms of animal or vegetable life, but have not been able or not disposed to incur the cost of such as are larger or more elaborate. To these, that which is now submitted to their notice is believed to offer peculiar advantages; in the convenience of its structure and its very moderate price, in connexion with its capabilities and the quality of its workmanship.

	£	s.	d.
The Microscope—with 1 inch and ¼ inch Object-Glasses, having the respective apertures of 22 and 75 degrees, and two Eye-pieces; a firm Stand with a joint for varying the position, quick and slow motions to the body, a Stage with springs that allow any motion to be given to the object; concave Mirror with complete adjustments; a side Condensing Lens; Diaphragm with a shutter; Forceps; Glass Plate, and pair of Pliers; packed in a strong Mahogany Case.....	10	0	0

ADDITIONAL APPARATUS.

Mahogany Board, required for packing any of the following parts	0	7	6
Lieberkuhn to 1 inch object-glass, and dark well	0	12	0
Wenham's Parabolic Reflector, for "dark-field illumination"	1	0	0
Flat Mirror (in which case, a double one is substituted for the single concave one which has to be returned) ...	0	7	6
Polarizing Apparatus, complete with prisms and selenite ...	1	12	6
Wollaston's Camera Lucida, for drawing an object.....	0	15	0
Glass Micrometer, ruled into $\frac{1}{100}$ths and $\frac{1}{1000}$ths of an inch.	0	5	0
Small Live Box	0	5	0
Glass Trough, complete with wedge and spring	0	6	6
All the above "Additional Apparatus" if ordered at once ...	5	0	0

Microscopic Objects.

[*Persons living in the country can have series of Objects sent for selection, on giving a satisfactory town-reference, and paying carriage both ways. One week will be allowed for examination.*]

	£	s.	d.
Vegetable Preparations :—			
Recent: Cells, Cuticles, Ducts, Fibre, Membrane, Spores, Sporules, Tissues, Spiral and other Vessels, Hairs, Leaves, Petals, Fungi, Sections of Woods, &c. .....each specimen	0	1	6
Fossil: Sections of various exogenous and endogenous Woods .....each section	0	1	6
Slides, with two and three sections..... 0 3 0 and	0	4	6
Desmidieæ and Algæ .....each slide	0	1	6
Diatomaceæ :—*Recent*: Several hundred varieties, including species of Campylodiscus, Cocconema, Epithemia, Navicula, Surirella, Synedra, &c.—*Fossil*: Specimens from various localities in the British Islands, Germany, Italy, North America, the East and West Indies, New Zealand, &c.	0	1	6
Spicules and Gemmules of Sponges and Gorgonias	0	1	6
Zoophytes, many species	0	1	6
Shells, sections of various species	0	1	6
Echinus Spines, sections in great variety.....	0	1	6
Entomological Preparations :—			
Antennæ, Eyes, Feet, Hairs, Scales, Skins, Spiracles, Stings, Stomachs, Tongues, Tracheæ, Wings, &c. Numerous specimens of Acari and Parasites	0	1	6
Hairs, Whiskers of various Animals mounted whole or in section, Quills, Feathers of Birds, &c.	0	1	6
Objects from Human and other Bodies	0	1	6
Anatomical Preparations :—			
Blood-Discs, Pigment-Cells, Skin, Muscular Fibre, Tissues, &c. .....from	0	1	6
Bones :—			
Transverse and Vertical Sections of 60 or 70 Recent and Fossil Mammals, Birds, Reptiles, and Fishes each slide	0	1	6
Teeth :—			
Transverse and Vertical Sections of about 30 varieties, Recent and Fossil .....each	0	2	0
Injected Preparations .....from	0	2	6
Polariscope Objects, about 100, selected from Animal, Vegetable, and Mineral Substances .....each	0	1	6
Mineralogical :—			
Sections of Limestones, Oolites, Flints, Agates, &c. each from	0	1	6

Cabinets for Objects,

in which the Specimens lie flat, and with Porcelain Labels to the Drawers.

Best Spanish Mahogany Cabinet, with glass panel, and to hold 1000 objects	7	0	0
Honduras ditto, without glass panel	6	6	0

	£	s.	d.
Best Spanish Mahogany Cabinet, with glass panel, and to hold 750 objects	5	15	0
Honduras ditto, without glass panel	5	0	0
Best Spanish Mahogany Cabinet, with glass panel, and to hold 500 objects	4	4	0
Honduras ditto, without glass panel	3	10	0

Cabinets made to any size, and of every description.

Cardboard Boxes, to hold two dozen objects	each	0	1	0
Ditto ditto one dozen ditto	„	0	0	9
Ditto ditto half dozen ditto	„	0	0	6
Single Mahogany Racks, for objects	per foot	0	0	6
Double ditto ditto	„	0	1	0

Instruments used in Preparing Objects.

Wood-cutting Machine with knife	0	15	0
Instrument for cutting Circles of thin Glass	1	5	0
Diamond for Writing or Cutting thin Glass	0	7	6
Ditto for plate and window Glass	0	18	0
Instrument for making Cells of gold-size or other fluids	0	7	6
Page's Wooden Forceps, for holding the glass slides when warmed	0	2	6
Small Brass Tables and Lamps for heating objects in mounting ..... from	0	10	6
Quekett's Forceps for deep jars	0	7	6
Ironwork of Dredge, for deep-water fishing	1	5	0
Small Collecting Bottles ..... per doz. 1*s.* 6*d.* to	0	3	0
Valentin's Knife, for making sections of soft substances	0	15	0
Small Dissecting Knives of various shapes ..... each	0	3	0

Spring Scissors, 7*s.* 6*d.*; Curved ditto, 5*s.*; Straight ditto, 3*s.*
Needle Holders, 5*s.*; Hooks, 2*s.* 6*d.*; Points, 2*s.* 6*d.*
Cutting Forceps, 5*s.* 6*d.*; Spring ditto, 3*s.*

Combination of three Lenses, mounted in Tortoiseshell, for pocket hand magnifiers	0	10	6
Ditto, with small brass stand	0	18	0
Coddington Lenses, in various mountings ..... from	0	9	0

Materials used in Mounting Objects.

Canada Balsam, Asphalt, Gold Size, Glycerine, &c., 1*s.* and 2*s.* bottles.
Deane's Gelatine Medium, 2s. bottles.
Thin Glass, in circles, 6*s.* per oz.; in squares, 4*s.* per oz.; ditto, mixed, 5*s.*
Plate-glass Slips, 3 inches by 1 inch, with ground edges, 1*s.* per doz.
Glass Cells, square, round, oblong, oval, and with solid bottoms, 2*s.* 6*d.* and 3*s.* per dozen.
Labels for covering objects, 3*s.* per hundred.

Woodward's Table and Hydro-Oxygen Polariscope and Microscope.

	£	s.	d.
Woodward's Table Polariscope and Microscope, with polarizing bundle, black glass, silvered reflector, and ground glass shade; large stage, with complete fittings, and two powers with rackwork motions, smaller stage for crystals; and box as stand, with complete fittings for apparatus	10	0	0
The above fitted as a Hydro-Oxygen Apparatus, with lantern, safety jet, bladders, and pressure boards; the Polariscope and Microscope Condensers, and an eye-lens to adapt to the lowest power ....extra	15	0	0
Clock for the Movement of Lime Cylinder	4	4	0
Lime Cylinders ....per dozen	0	3	6
Tourmalines for the above instrument ....from	1	0	0
Selenite objects for ditto .... „	0	5	0
Glass, Quartz, and other Prisms; together with all matters relating to Polarization.			

Books.

Smith on the British Diatomaceæ, Vol. I.	1	1	0
Ditto ditto 2nd vol. now publishing.....			
Quekett on the Microscope, 2nd Edition	1	2	0
Quekett's Lectures on Histology	0	10	6
Ditto ditto 2nd vol.	0	18	0
Woodward on Polarized Light, 2nd Edition	0	3	0
Wythes on the Microscope	0	6	0
Hassall's British Freshwater Algæ, 2 vols.	2	5	0
Hassall's Microscopic Anatomy of the Human Body	2	5	0
Microscopic Quarterly Journal .... each number	0	4	0
Micrographic Dictionary	2	5	0

Telescopes.

1-foot Achromatic Telescope	1	12	0
Ditto ditto made very light	1	15	0
20-inch Achromatic Telescope	2	10	0
20-inch Achromatic Telescope, 2 drawers, leather body	3	3	0
Ditto ditto ditto for Deerstalking	3	10	0
2-feet Achromatic Telescope, 3 drawers	3	10	0
2-feet Achromatic Telescope, 8 drawers, portable	4	4	0
2-feet Achromatic Telescope, 8 drawers, portable, on brass tripod stand, in small mahogany case	6	0	0
30-inch Achromatic Telescope, 3 drawers	4	15	0
30-inch Achromatic Telescope, 3 drawers, on brass tripod stand, in mahogany case	9	0	0
3-feet Achromatic Telescope	6	6	0
3-feet Achromatic Telescope, on brass tripod stand, in mahogany case	10	10	0
3-feet Achromatic Telescope, 1 terrestrial and 1 astronomical eye-piece, pillar and claw stand, and mahogany case ...	14	14	0

	£	s.	d.
3½-feet Achromatic Telescope, with finder, 1 terrestrial and 4 astronomical eye-pieces, on brass pillar and claw stand, with vertical and horizontal rack movements, and steadying-rods, in mahogany case	40	0	0
Ditto on improved stand	42	0	0
Mahogany stand for ditto and bolt	1	1	0
Universal Equatorial stand for ditto	30	0	0
Varley's Stand, mahogany with brass fittings	12	12	0
Sling cases for portable Telescopes ..... from	0	7	6

Larger Telescopes, with every variety of mounting, made to order.

Spectacles and Eye-Glasses.

Gold Spectacles, double joint	from	1	15	0	to	3	3	0
Gold Spectacles, single joint.....	„	1	10	0	to	3	0	0
Plated Spectacles	„	1	10	0				
Gold Folders	„	2	15	0	to	5	5	0
Plated Folders	„	2	0	0				
Gold Eye-frames	„	0	10	0	to	2	0	0
Plated Eye-frames.....	„	0	14	0				
Silver Spectacles and Folders	„	1	0	0				
Pearl or Tortoiseshell and Gold Hand-frames.....	„	4	4	0	to	5	5	0
Pearl or Tortoiseshell and Silver Hand-frames.....	„	1	1	0				
French Tortoiseshell and Silver Hand-frames.....	„	0	17	0				
Tortoiseshell Spectacles, double-joint						0	12	6
Tortoiseshell Spectacles, single-joint						0	10	6
Tortoiseshell Folders.....	from	0	7	0	to	0	18	0
Tortoiseshell Folders, with gold bridge.....						1	6	0
Tortoiseshell Eye-glasses	from	0	3	0	to	0	6	0
Fine Blue Steel Spectacles, double-joint						0	14	0
Fine Blue Steel Spectacles, single-joint						0	13	0
Common Blue Steel Spectacles	from	0	5	0				
Spectacles, with tinted glasses	„	0	11	0				
Horse-shoe Frames, with tinted glasses..	„	1	1	0				
Railway Spectacles	„	0	14	0				
New Glasses to Spectacles, convex.....	per pair					0	3	0
New Glasses to Spectacles, concave	per pair					0	4	0
Double for Brazilian Pebbles.								
Spectacle Cases	from					0	1	0

Reading Glasses of every variety	from	0	3	0	to	2	2	0
Opera Glasses, Race Glasses, Horizon Sweeps, &c. &c.....	„	0	12	0	to	9	9	0

Stereoscopes.

	£	s	d.
Mahogany Stereoscope, and Diagrams	0	15	0
Tin Stereoscope, and Diagrams	0	3	0
Photographic Views on glass ... from	0	5	0
Daguerreotypes ... from 0 7 6 to	0	12	6
Talbotypes ... „ 0 2 6 to	0	5	0
Diagrams, &c. &c.			
Spanish Mahogany Box to hold 2 stereoscopes and 24 slides	2	2	0
Spanish Mahogany Box to hold 1 stereoscope and 32 slides	2	2	0
Spanish Mahogany Box to hold two dozen slides	1	4	0
Spanish Mahogany Box to hold one dozen Slides	0	14	0

Cases for Stereoscopes and Slides made to Order.

Drawing Instruments, &c.

Wollaston's Camera Lucida, mounted ... from 1 10 0 to	3	0	0
Drawing Instruments for school use ... from	0	7	6
Ditto ditto in mahogany case	1	5	0
Ditto ditto in superior case, 3 ivory rules	3	5	0
Ditto ditto ditto in electrum	3	15	0
Ditto ditto ditto ditto double-jointed	6	0	0
Beam Compasses ... from	1	15	0
12-inch Ivory Plotting Scales ... from 0 7 6 to	1	0	0
12-inch Boxwood Plotting Scales, set of 3, with offsets	0	11	0
Ivory Folding Rules ... from	0	6	0
Boxwood Folding Rules ... „	0	1	0
Plain Ebony Parallel Rules ... „	0	4	0
Plain Rolling Ebony Parallel Rules ... „	0	9	0
Ivory-edged and graduated Parallel Rules ... per inch	0	1	6

Barometers, Thermometers, &c.

Pediment Barometers ... from	3	0	0
Pediment Barometer, best, with float gauge ...	9	0	0
Wheel Barometers ... from	2	2	0
Standard Thermometer ... „	2	10	0
Negretti's Maximum Thermometer ...	1	1	0
Six's Self-registering Thermometer ...	1	10	0
Horizontal Self-registering Thermometer ...	0	17	0
Boxwood Thermometers ... from	0	3	6
Simmons's Hygrometer ...	2	2	0

Rain Gauges to Order.

Air-Pumps and Electrical Machines

TO ORDER.

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